



88015351

PHASE I

Geology, Energy and Mineral (GEM) Resource
Assessment of the Donkey Hills GRA, Idaho,
including the Hawley Mountain (32-3),
Goldburg (45-1), Burnt Creek (45-12), and
Borah Peak (47-4) Wilderness Study Areas

Bureau of Land Management

4
6
7
33
2

4001111111
P.O. BOX 11
718 N. 1ST ST.
ANCHORAGE, ALASKA 99501

88015351

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

QE
104
.D66
F47
1983
C.2

PHASE I

Geology, Energy and Mineral (GEM) Resource
Assessment of the Donkey Hills GRA, Idaho,
including the Hawley Mountain (32-3),
Goldburg (45-1), Burnt Creek (45-12), and
Borah Peak (47-4) Wilderness Study Areas

Bureau of Land Management
Contract No. YA-553-CT2-1039

By:

Greg Fernette
Joel Stratman

Contributors:

G. Webster
D. Blackwell
C.G. Bigelow
R.S. Fredericksen
J. Bressler
W.C. Jones
E.F. Evoy
J.F. McOuat

ANCHORAGE, ALASKA
SEPTEMBER 1983

WGM INC.
MINING AND GEOLOGICAL CONSULTANTS

EXECUTIVE SUMMARY

The Donkey Hills GRA encompasses about 625 square miles in east-central Idaho (Dubois 1°x2° Quadrangle), and it includes the Hawley Mountain (32-3), Goldburg (45-1), Burnt Creek (45-12), and Borah Peak (47-4) WSAs. The largest town in the area is Mackay, 10 miles south of the GRA. Access to the GRA is by U.S. 93 or an improved paved/gravel road from Howe or Ellis, Idaho.

The Donkey Hills GRA is within the Northern Rocky Mountains physiographic province. The GRA includes part of the southern Lost River Range, a small portion of the adjacent Lemhi Range, the southern Pashsimeroi Valley, the Donkey Hills and the Hawley Mountains.

The GRA is Underlain by allochthonous Precambrian and Paleozoic sediments which have been thrust northeast from their depositional site which was 150 to 200 miles southwest. Extensive volcanism occurred about 51 to 45 m.y. ago, after thrusting. Major basin-and-range faulting began about 17 m.y. ago. Some of the later faults are probably still active.

Mineralization within the Donkey Hills GRA consists of (1) contact metamorphic and vein deposits of base and precious metals, (2) lead-zinc-barite mineralization in carbonate rocks, and (3) copper-cobalt mineralization in Precambrian metasediments. None of the known occurrences are in a WSA. The Goldburg WSA is just south of two occurrences and is underlain by similar rocks; thus, it is classified as moderately favorable for metallic

deposits. The remaining WSAs are classified as having low favorability for metallic resources.

During the NURE study of the Dubois Quadrangle, it was found that the McGowan Creek Formation was uraniferous in the Beaverhead Mountains; thus, examination of this unit in the Lost River Range was recommended. As a result, the areas underlain by the McGowan Creek in the Hawley Mountain and Burnt Creek WSAs are classified as moderately favorable for uranium deposits.

The Donkey Hills GRA is in the "overthrust belt" and most of it, including the WSAs, is under lease for oil and gas. Limited available evidence indicates that both hydrocarbon source and reservoir rocks are present in the subsurface of the GRA; therefore, all four WSAs are classified as moderately favorable for the accumulation of oil and gas.

In central Idaho, basin-and-range structures appear to influence the location of geothermal springs. One warm spring is present in the middle of the Lost River Valley, but its control is unknown. Based on the small amount of information available those areas at low elevations overlying major lineaments or possible range-bounding faults are classified as having low favorability for geothermal resources. The remaining, topographically high, areas are classified as unfavorable for geothermal resources.

Several areas in the WSAs are classified as having moderate to high favorability for either limestone and dolomite or sand and gravel. However, the

long transportation distance to any major market for these commodities renders them uneconomic.

The classification of the four WSAs for resource potential is summarized in the accompanying table.

DONKEY HILLS GRA, IDAHOSUMMARY OF GEM RESOURCES CLASSIFICATION

<u>Resource</u>	<u>32-3</u>	<u>Wilderness Study Areas</u>			<u>47-4</u>
		<u>45-1</u>	<u>45-12</u>		
1. Locatable					
a. Metallic Minerals	2C	3B	2B		2C
b. Uranium and Thorium	3B/1C	1C	1C/3B		1C
c. Non-Metallic Minerals	2C	1C	1C		2C
2. Leasable					
a. Oil and Gas	3C	3B	3C		3C
b. Geothermal (L)	2B/1B	2B/1B	2B/1B		2B/1B
Geothermal (H)	2B/1B	2B/1B	2B/1B		2B/1B
c. Sodium-Potassium	1C	1C	1C		1C
d. Other (1)	1C	1C	1C		1C
3. Saleable	4D/3D	2C	2C		3C/1C

(1) Includes oil shale, asphalt, phosphate and bitumen.

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
1.1 Location	3
1.2 Population and Infrastructure	3
1.3 Basis of Report	3
1.4 Acknowledgements	6
2.0 GEOLOGY	7
2.1 Introduction	7
2.2 Physiography	8
2.3 Rock Units	8
2.4 Structural Geology and Tectonics	25
2.5 Paleontology	30
2.6 Historical Geology	32
3.0 ENERGY AND MINERAL RESOURCES	36
3.1 Known Mineral and Energy Deposits	36
3.2 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas	39
3.3 Mining Claims, Leases and Material Sites	40
3.4 Mineral and Energy Deposit Types	42
3.5 Mineral and Energy Economics	58
4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL	60
4.1 Explanation of Classification Scheme	60
4.2 Classification of the Hawley Mountain WSA (32-3)	63
4.2.1 Locatable Minerals	63
4.2.2 Leasable Resources	66
4.2.3 Saleable Resources	69
4.3 Classification of the Goldburg WSA (45-1)	69
4.3.1 Locatable Minerals	69
4.3.2 Leasable Resources	72
4.3.3 Saleable Resources	73
4.4 Classification of the Burnt Creek WSA (45-12)	74
4.4.1 Locatable Minerals	74
4.4.2 Leasable Resources	75
4.4.3 Saleable Resources	76
4.5 Classification of the Borah Peak WSA (47-4)	76
4.5.1 Locatable Minerals	76
4.5.2 Leasable Resources	77
4.5.3 Saleable Resources	78

TABLE OF CONTENTS (Cont.)

	<u>Page</u>
5.0 RECOMMENDATIONS FOR FURTHER WORK	79
6.0 REFERENCES AND SELECTED BIBLIOGRAPHY	81
APPENDIX I: WILDERNESS STUDY AREA MAPS	88
APPENDIX II: FIELD VISIT REPORT	93

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	
1.1 Location	
1.2 Population and Infrastructure	
1.3 Basis of Report	
1.4 Acknowledgements	
2.0 GEOLOGY	
2.1 Introduction	
2.2 Physiography	
2.3 Rock Units	
2.4 Structural Geology and Tectonics	
2.5 Paleontology	
2.6 Historical Geology	
3.0 ENERGY AND MINERAL RESOURCES	
3.1 Introduction	
3.2 Known Mineral and Energy Deposits	
3.3 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas	
3.4 Mining Claims, Leases and Material Sites	
3.5 Mineral and Energy Deposit Types	
3.6 Mineral and Energy Economics	
4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL	
4.1 Explanation of Classification Scheme	
4.2 Classification of the Hawley Mountain WSA (32-3)	
4.3 Classification of the Goldburg WSA (45-1)	
4.4 Classification of the Burnt Creek WSA (45-12)	
4.5 Classification of the Borah Peak WSA (47-4)	
5.0 RECOMMENDATIONS FOR FURTHER WORK	
6.0 REFERENCES AND SELECTED BIBLIOGRAPHY	
APPENDIX I: WILDERNESS STUDY AREA MAPS	
APPENDIX II: FIELD VISIT REPORT	

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Location Map	2
2	Topographic Map	4
3	Physiographic Setting	9
4	Stratigraphic Column	10
5	Geologic Map	13
6	Regional Geologic Setting	26
7	Structural Setting	27
8	Regional Seismicity	31
9	Mineral and Energy Occurrences	37
10	Mining Claims Density	41
11	Oil and Gas Lease Status	43
12	Geochemical Sample Locations Goldburg WSA	50
13	Regional Mineralization	52
14	Land Classification - Locatable Resources	65
15	Land Classification - Leaseable Resources	68
16	Land Classification - Saleable Resources	71

LIST OF TABLES

<u>Table</u>		<u>Page</u>
I	Mineral and Energy Prospects and Occurrences in the Donkey Hills GRA, Idaho	38
II	Oil and Gas Leases in the Donkey Hills GRA, Idaho	44
III	Analytical Results from Stream Silt Samples - Goldburg WSA	51
IV	Summary of Uranium Geochemical Sampling, Donkey Hills GRA, Idaho	53
V	Bureau of Land Management GEM Resources Land Classification System	61

DONKEY HILLS GRA, IDAHO1.0 INTRODUCTION

The Bureau of Land Management has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data into the suitable/non-suitable decision-making process for Wilderness Study Area (WSAs). The objective of Phase I is the evaluation of existing data, both published and available unpublished data, for interpretation of the GEM resource potential of the WSAs. Wilderness Study Areas are grouped into areas based on geologic environment and mineral resources for initial evaluation. These areas are referred to as Geology, Energy, Mineral Resource Areas (GRAs).

The delineation of the GRAs is based on three criteria: (1) a 1:250,000 scale map of each GRA shall be no greater than 8½ x 11 inches; (2) a GRA boundary will not cut across a Wilderness Study Area; and (3) the geologic environment and mineral occurrences. The data for each GRA is collected, compiled, and evaluated and a report prepared for each GRA. Each WSA in the GRA is then classified according to GEM resources favorability. The classification system and report format are specified by the BLM to maintain continuity between regions.

This report is prepared for the Bureau of Land Management under contract number YA-553-CT2-1039. The contract covers GEM Region 2; Northern Rocky Mountains (Fig. 1). The Region includes 50 BLM Wilderness Study Areas

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

**BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS**

***Donkey Hills GRA,
Idaho
Location Map***

SCALE 1"=45 MILES

DATA BY WGM

DATE 12/1982

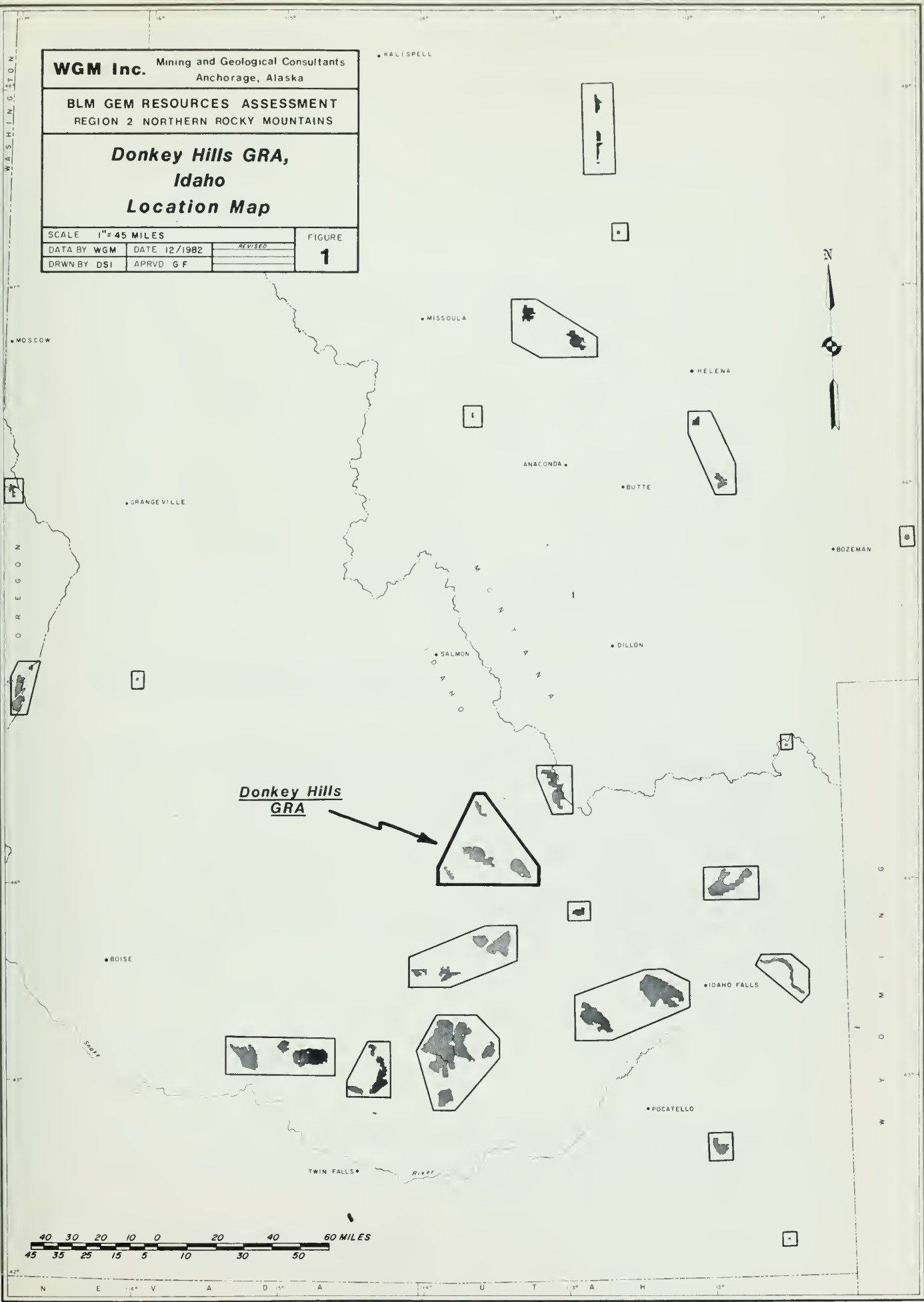
REVISED

DRWN BY DSI

APRVD G F

FIGURE

1



totalling 583,182 acres. The WSAs were grouped into 22 GRAs for purposes of the Phase I GEM resources evaluation.

1.1 Location

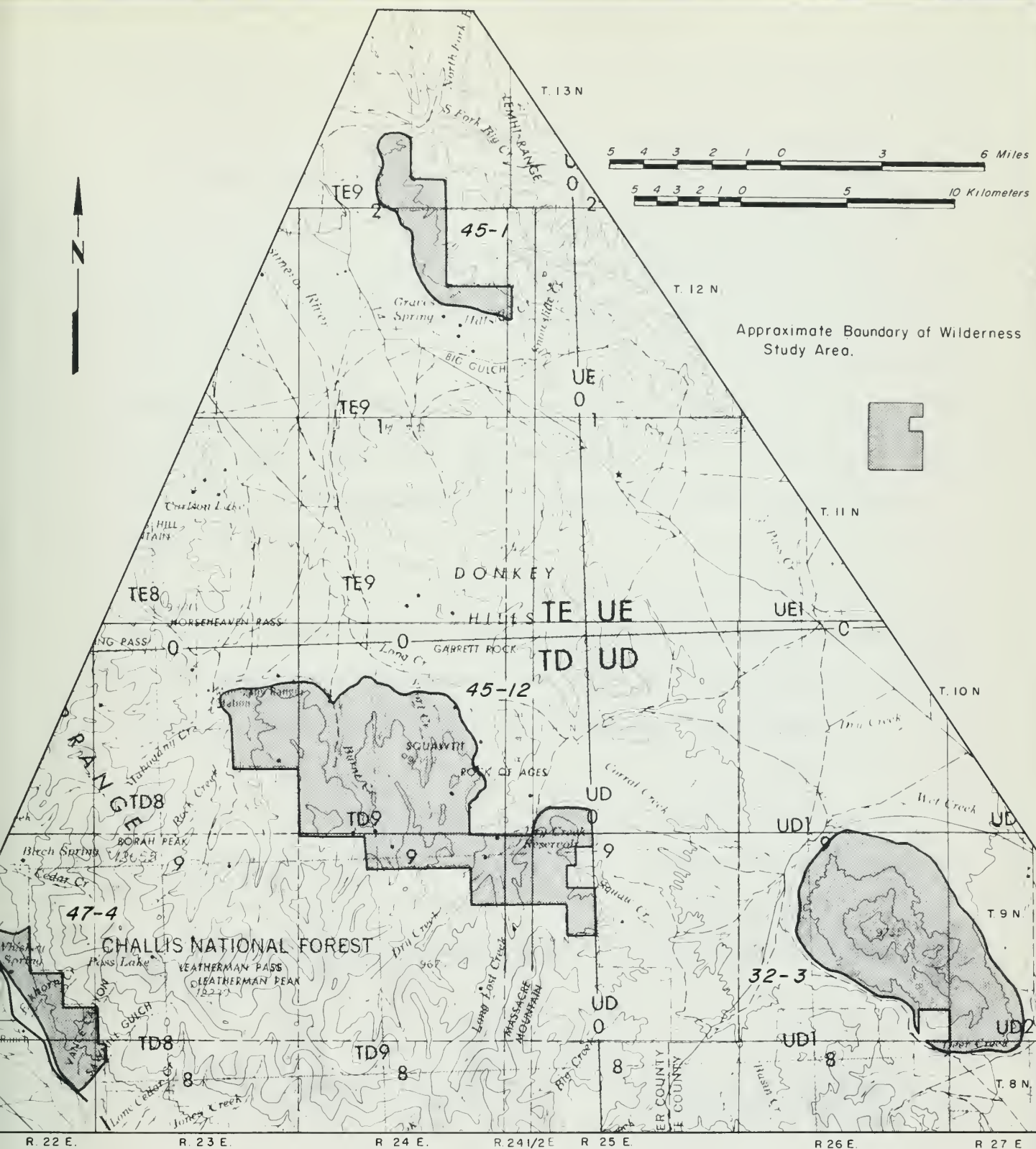
The Donkey Hills GRA encompasses about 625 square miles near the junction of Custer, Butte and Lemhi Counties, central Idaho, and it includes all or parts of Ts.8-13N., Rs.22-27E. (Fig. 2) in the Dubois Idaho-Montana 2° Quadrangle. The GRA contains four Wilderness Study Areas (WSAs): Hawley Mountain (32-3), Goldburg (45-1), Burnt Creek (45-12) and Borah Peak (47-4). The WSAs comprise a total of 46,880 acres (Fig. 2). The GRA lies within the Pahsimeroi and Challis Resource Areas of the Salmon BLM district and within the Butte Resource Area of the Idaho Falls BLM district.

1.2 Population and Infrastructure

The town of Mackay (pop. 541), approximately 10 miles south of the Donkey Hills GRA is the largest town in the immediate area. U.S. Highway 93 traverses the southwestern corner of the GRA and a partly paved and partly gravel road between Howe and Ellis, Idaho passes through the northern part of the GRA. Numerous jeep trails and unimproved surface roads are present within the GRA.

1.3 Basis of the Report

This report is based on a review, compilation and analysis of available published and unpublished data on the geology, energy and mineral resources



**BLM Wilderness Study Areas Included in the
Donkey Hills GRA.**

WSA	NAME	ACREAGE
32-3	Hawley Mountain	15,510
45-1	Goldburg	3,290
45-12	Burnt Creek	24,980
47-4	Borah Peak	3,100

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

**BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS**

**Donkey Hills GRA, Idaho
Topographic Map**

SCALE 1"=4 MILES (1:250,000)

DATA BY: WGM DATE: 9/1982

DRWN BY: DSI APRVD: GF

FIGURE

2

of the Donkey Hills GRA. Geological mapping in the GRA includes 1:125,000 scale mapping by Ross (1947) and 1:62,500 scale mapping in the eastern part of the GRA by Mapel and Shropshire (1973) and Ruppel and Lopez (1981). Mineral compilations by the Idaho Bureau of Mines and Geology cover the Dubois Quadrangle (Mitchell et al., 1981). A NURE report also covers the Dubois Quadrangle (Wodzicki and Krason, 1981). The U.S. Bureau of Mines' Mineral Industry Location System (MILS) for the Dubois Quadrangle was also consulted. Mining claim and oil and gas lease information was compiled from BLM land records. Published LANDSTAT material was also reviewed. A one-day field examination was made in the Goldburg WSA in October 1982 by WGM geologists.

The data were compiled and reviewed by WGM project personnel and the panel of experts to produce the resource evaluation which comprises this report. Personnel involved in the report preparation are listed below.

Greg Fernette, Senior Geologist, WGM Inc.	Project Manager
C.G. Bigelow, President, WGM Inc.	Chairman, Panel of Experts
Joel Stratman, Geologist, WGM Inc.	Project Geologist
Jami Fernette, Land and Environmental Coordinator, WGM Inc.	Claims and Lease Compilation

Panel of Experts

C.G. Bigelow, President, WGM Inc.	Regional geology, metallic and minerals, mineral economics.
R.S. Fredericksen, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
David Blackwell, Ph.D., Professor Geophysics, Southern Methodist University	Geothermal.

Jason Bressler, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
Gary Webster, Ph.D., Chairman, Department of Geology, Washington State University	Oil and gas.
William Jones, Senior Geologist, WGM Inc.	Metallic minerals, coal, industrial minerals.
J.F. McOuat, President, Watts, Griffis & McOuat Ltd.	Mineral economics, and industrial minerals.
E.F. Evoy, Senior Geologist, Watts, Griffis & McOuat Ltd.	Uranium and thorium.

1.4 Acknowledgements

We are indebted to Tim Carroll, BLM District Geologist for the Idaho Falls district, and to George Babbitts, BLM District Geologist for the Salmon district, for their assistance during the compilation phase of this report.

2.0 GEOLOGY

2.1 Introduction

The Donkey Hills GRA is underlain by allochthonous Precambrian (older than 600 m.y.) metasediments and Paleozoic (600-230 m.y.) sediments. These rocks have been thrust northeast from their original depositional site which was 150 to 200 miles southwest during crustal shortening which probably began in Early Cretaceous (141-100 m.y.) and lasted until the Paleocene (65-55 m.y.). Extensive volcanism occurred about 51 to 45 m.y. ago. Major basin-and-range faulting began in the area about 17 m.y. ago resulting in the uplift of fault-bounded blocks. Lesser normal faulting is probably still in progress. Erosion of the uplifted fault-bounded mountain ranges during Quaternary (2 m.y. to present) resulted in development of the present topography.

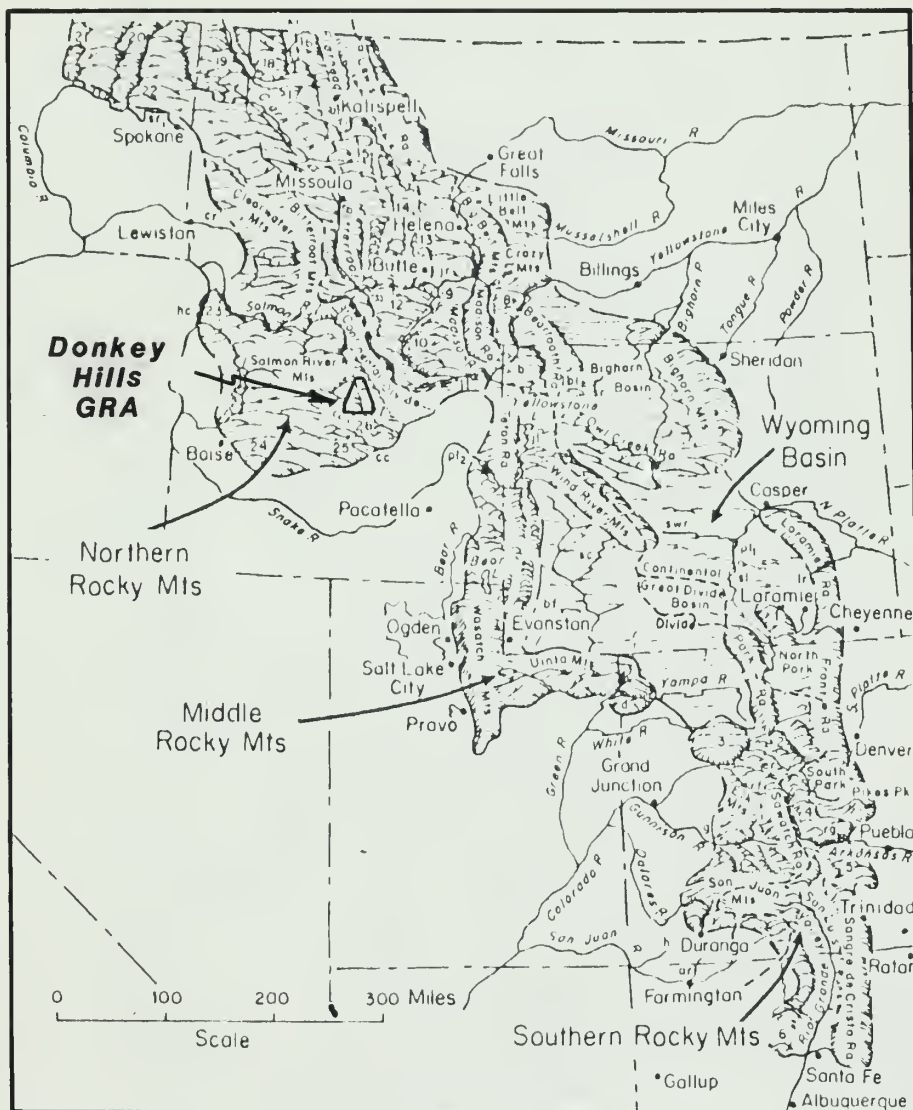
The western part of the Donkey Hills GRA has been mapped at a scale of 1:125,000 (Ross, 1947) and the eastern portion of the GRA has geologic map coverage at a 1:62,500 scale (Mapel and Shropshire, 1973; Ruppel and Lopez, 1981). Rember and Bennett (1979) compiled all of the mapping at a scale of 1:250,000. Regional stratigraphic studies which include the GRA have been published by Ruppel (1975), Ruppel et al. (1975), Sandberg (1975), Scholten and Hait (1962), Skipp et al. (1979), and Skipp (1981). Regional structural investigations pertaining to the Donkey Hills GRA include papers by Hait and Scott (1978), Ruppel (1964), Ruppel (1982), Skipp (1981) and Skipp and Hait (1977).

2.2 Physiography

The Donkey Hills GRA is near the southern border of the Northern Rocky Mountains physiographic province (Hunt, 1974) (Fig. 3). The GRA includes the rugged northwest-trending Lost River Range, a small portion of the less rugged Lemhi Range and the broad intermountain valley separating the two mountain ranges. The valley is partially interrupted by the Donkey Hills. The highest point in the GRA is Borah Peak, elevation 12,655 feet, while the lowest points are in the intermountain valleys, approximately 6,000 feet above sea level. Most drainages in the GRA are tributaries of the Salmon River, mainly via the Pashsimeroi River. Drainages in the southwest and southeast portions of the Donkey Hills GRA enter the Snake River system.

2.3 Description of Rock Units

The oldest rocks in the Donkey Hills GRA belong to a group Precambrian Y (1600-600 m.y.) sedimentary rocks which crop out in a 150 mile long belt in east-central Idaho from the Snake River Plain northward to the Idaho-Montana border at Lost Trail Pass. In the Donkey Hills GRA these rocks consist of a thick sequence of impure grayish-green fine-grained feldspathic quartzites and argillitic siltites belonging to the Lemhi Group and the overlying Swauger Formation (Fig. 4). The Lemhi Group is divided into five units: (1) the Inyo Creek Formation (oldest), (2) the West Fork Formation, (3) the Big Creek Formation, (4) the Apple Creek Formation, and (5) the Gunsight Formation (youngest). Only the Gunsight Formation and the Swauger Formation are exposed in the GRA. Thickness of the Lemhi Group is about 20,000 feet and the Swauger Formation is at least 10,000 feet thick (Ruppel,



Data from: Hunt(1974).

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho
Physiographic Setting

AS SHOWN	DATE	1/1983	SCALE
DRAWN BY	DSI	BY	GF
			3

ERA	SYSTEM	SERIES	FORMATION		THICKNESS (FEET)
CENOZIC	EOCENE		CHALLIS VOLCANICS	BASALTIC TO RHYOLITIC FLOWS AND TUFFS	9500
PALEOZOIC	PERMIAN		SHAWY CANYON FORMATION	UNCONFORMITY	3500
	PENNSYLVANIAN	LATE		JUNIPER GULCH MEMBER	
		MIDDLE		GALLAGHER PEAK MEMBER	
		EARLY		BLOOM MEMBER	
	MISSISSIPPIAN	LATE		BLUEBIRD MOUNTAIN FORMATION	150
				ARCO HILLS FORMATION	155 - 250
				SURRETT CANYON FORMATION	850
				SOUTH CREEK FORMATION	220
		EARLY		SCOTT PEAK FORMATION	2040
				MIDDLE CANYON FORMATION	680 TO 725
				MCGOWAN CREEK FORMATION	100 TO 860
				UNCONFORMITY	
	DEVONIAN	LATE		THREE FORKS FORMATION	150 TO 300
		MIDDLE		JEFFERSON DOLOMITE	2700
	SILURIAN			UNCONFORMITY	
				LAKETOWN DOLOMITE	0 TO 500
	ORDOVICIAN	LATE		SATURDAY MOUNTAIN FORMATION	1170
		MIDDLE		KINNICKINIC QUARTZITE	985 TO 1800
		EARLY		UNCONFORMITY	
					SUMMERHOUSE FORMATION
UNCONFORMITY			UNCONFORMITY		
	PRE-CAMBRIAN Z			WILBERT FORMATION	0 TO 1000
PRE-CAMBRIAN Y		LEMMI GROUP		UNCONFORMITY	
			SWAUGER FORMATION	0 TO 10,000	
			GUNSIGHT FORMATION	ABOUT 20,000	
			APPLE CREEK FORMATION		
			BIG CREEK FORMATION		
			WEST FORK FORMATION		
			INYO CREEK FORMATION		

FROM: RUPPEL & LOPEZ (1981)
MAPEL & SHROPSHIRE (1973)
SKIPP et. al. (1979)

WGM Inc.			Mining and Geological Consultants Anchorage, Alaska
BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS			
Donkey Hills GRA, Idaho			
Stratigraphic Section			
SCALE			
DATA BY	DATE	REV. SEC.	
DRWN BY	APPRD		
			FIGURE 4

1975). Correlation of these rocks with the Belt Supergroup in western Montana and northern Idaho is tenuous because of differing characteristics between the two sequences as a result of differing depositional conditions. The Belt Group was deposited in the Belt basin whereas the east-central Idaho rocks were deposited in the Belt miogeocline. Ruppel (1975) suggests that on the basis of lithology, the Apple Creek Formation may be the equivalent of the middle belt carbonates belonging to the Wallace Formation and the Helena Dolomite. Additionally, striking differences between the Swauger Formation and the underlying Lemhi Group may reflect tectonic adjustments that took place during Missoula time; thus, the Swauger would be equivalent to part or all of the Missoula Group and the Gunsight Formation at the top of the Lemhi Group could be equivalent to part of the Wallace Formation (Ruppel, 1975).

The Gunsight Formation, the uppermost unit in the Lemhi Group and the oldest rock exposed in the Donkey Hills GRA (Fig. 5), consists of light-brownish-gray to grayish-red-purple, fine- to medium-grained feldspathic quartzite. Abundant detrital grains of magnetite are scattered through the rock and concentrated in laminae. Feldspar content averages 10% to 20% of the rock. Individual beds are 1 to 4 feet thick, commonly laminated and cross-laminated, and often deformed by soft-sediment slumping. Siltstone and argillite partings and a few interbeds of grayish-yellow-green to light-olive-gray fine-grained quartzite, are present throughout the formation. Both upper and lower contacts are gradational and thickness is estimated to be 6,000 feet (Ruppel and Lopez, 1981).

Donkey Hills GRA, Idaho **Legend for Figure 5**

EXPLANATION

Sedimentary

Igneous

CENOZOIC

Qal

Stream alluvium

Qls

Landslide debris

Qtg

Terrace gravel

Qpg

Pediment gravel

Qf

Alluvial fans

Qg

Glacial deposits

Tdf

Dankey
Fanglomerate

Tcl

Tcb

Tct

Tcb Basalt

Tcl Latite and andesite

Tct Tuff

Challis Volcanics

PERMIAN

Pl

Ps

Msu

Mso

Msp

Mmd

Mmg

PMu

Pl

limestone

Ps

sandstone

Msu

Surrett Canyon Formation

Mso

South Creek Formation

Msp

Scott Peak Formation

Mmd

Middle Canyon Formation

Mmg

McGowan Creek Formation

PMu

Undifferentiated Upper Mississippian and Pennsylvanian rocks.

Msm

Surrett Canyon, South Creek, Scott Peak and Middle Canyon Formations, undifferentiated.

MISSISSIPPIAN

PALEOZOIC

Pt

Three Forks Formation

Dj

Jefferson Dalamite

SDu

Silurian - Devonian undifferentiated

Sl

Laketown Dalamite

SOs

Silurian rocks and Saturday Mountain Formation

Osm

Saturday Mountain Formation

OK

Kinnikinnic Quartzite

Osh

Summerhouse Formation

DEVONIAN

SILURIAN

ORDOVICIAN

PRECAMBRIAN

pCw

Wilbert Formation

pCsq

pCsa

Swauger Quartzite

Argillaceous beds

pCg

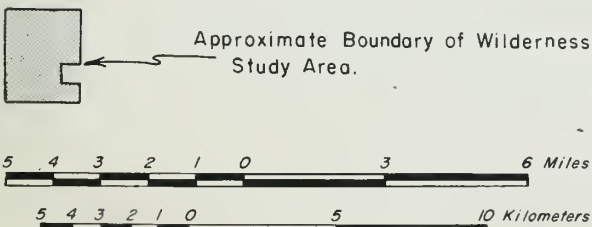
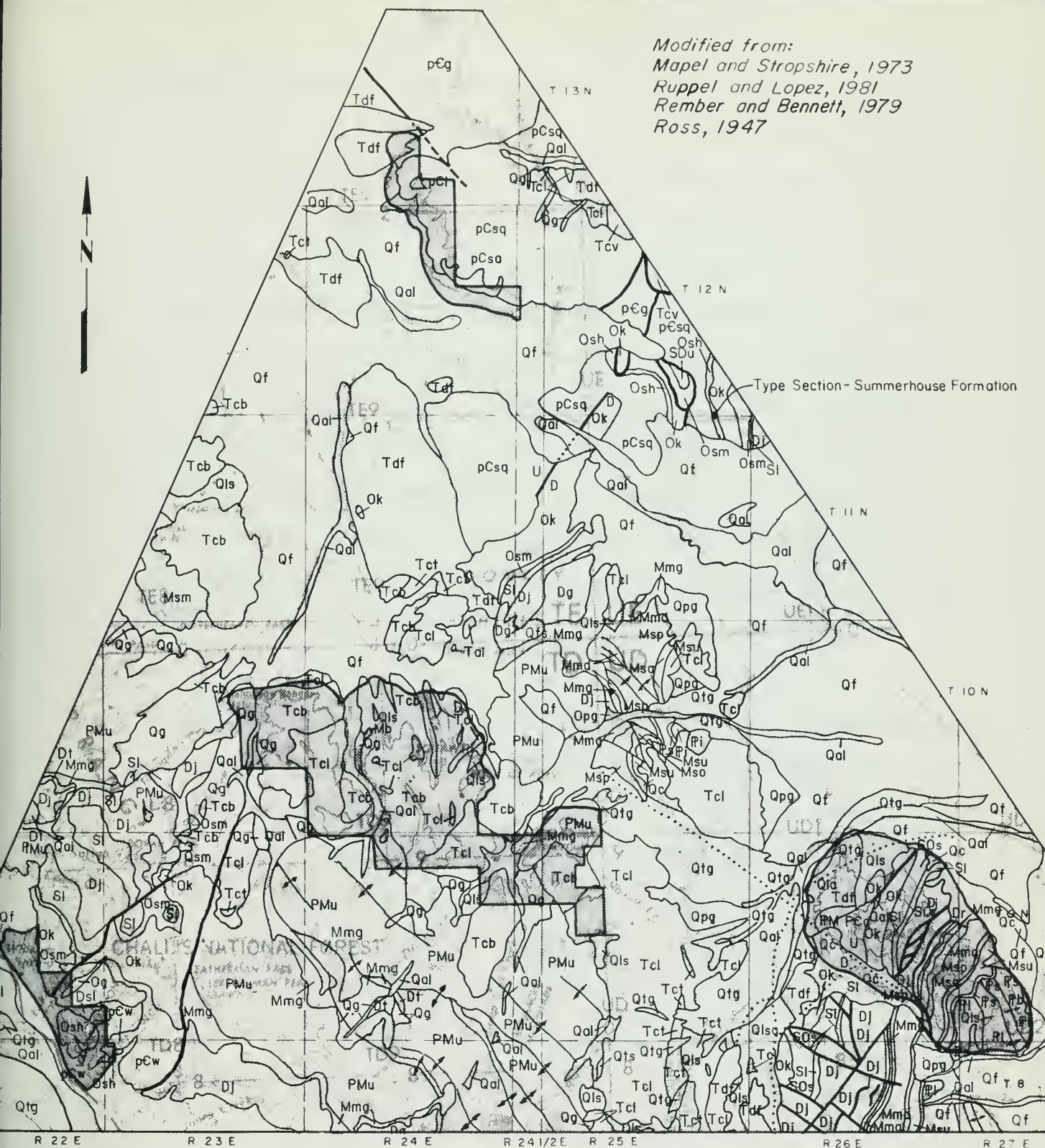
Gunsight Formation

Z

Y

Data by: Rember and Bennett, 1979
 Mapel and Stropshire, 1973
 Ruppel and Lopez, 1981
 Ross, 1947

Modified from:
 Mapel and Stropshire, 1973
 Ruppel and Lopez, 1981
 Rember and Bennett, 1979
 Ross, 1947



WGM Inc. Mining and Geological Consultants
 Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
 REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho

Geologic Map

SCALE 1"=45 MILES	FIGURE
DATA BY WGM DATE 1/1983	REVISED
DRAWN BY DSI	APPROVED G.F.

5

The overlying Swauger Formation consists of grayish-pink to pale-purple or pale-red-purple and less commonly light brown to grayish-green hematitic quartzite that is only slightly feldspathic. Beds within the unit are 3-6 feet thick, often prominently and coarsely cross-bedded, and occasionally, ripple marked. Quartz grains are vitreous, well-sorted and well-rounded. The beds, particularly in the lower part of the formation, are separated by partings and beds, generally up to six inches thick but rarely up to three feet thick, of greenish-gray to dark-grayish-green siltite or argillite. A purplish speckling or blotching from hematite is characteristic of weathered Swauger. An extensive unconformity is present at the top of the Formation which results in thickness ranges of from 0 to 1,000 feet (Ruppel, 1975). The Goldberg WSA is predominately underlain by the Swauger Formation (Fig. 5).

In east-central Idaho, a confusing and controversial sequence of calcareous sandstones, shales and quartzitic rocks is present between the Precambrian Y rocks and the Middle Ordovician (479-450 m.y.) Kinnikinic Quartzite. The discovery of Early Ordovician (500-479 m.y.) fossils in the upper part of the sequence, along with recognition of angular unconformities at the base, middle and top of the sequence, has resulted in the separation of the sequence into the Wilbert Formation, tentatively of Precambrian Z (800-600 m.y.) age, and the Summerhouse Formation of Early Ordovician age (Ruppel et al., 1975).

The Wilbert Formation is dominately brownish-gray to pale-red quartzitic fine to coarse sand, grit, or conglomerate. The unit is poorly sorted, partly laminated and cross-laminated, hematitic, occasionally glauconitic,

and partly calcareous. A few beds of sandy limestone and dolomite as well as a few beds of siltstone, shale and fine-grained quartzite are present in the upper Wilbert. Thickness of the unit ranges from 0 to about 1,000 feet (Ruppel et al., 1975).

The overlying Summerhouse Formation appears to represent a near-shore, perhaps lagoonal environment; thus, the unit differs widely in lithology and thickness. The type section for the Summerhouse is on the east wall of Summerhouse Canyon (SE $\frac{1}{4}$, SE $\frac{1}{2}$, sec. 25, T.12N., R.25E.) within the Donkey Hills GRA (Fig. 5). At the type locality from the top to the base, the Summerhouse includes: an upper pale red to nearly white Scolithus-bearing sandstone, around 200 feet thick; underlain successively by about 165 feet of yellowish-brown Scolithus-bearing calcareous glauconitic sandstone; about 490 feet of irregularly interbedded pink to nearly white sandstone and quartzite; around 85 feet of sandy, locally pebbly fossiliferous limestone; and at the base, about 65 feet of light- to yellowish-gray, fine- to very fine-grained, vitreous quartzite. Conodonts from the Summerhouse Formation near North Creek, about 33 miles southeast of the type section, indicate an Early Ordovician age for the Formation. In addition, trilobites and brachiopods collected from the Summerhouse at the type locality indicate that it is correlative with the Garden City Formation south of the Snake River Plain supporting an Early Ordovician age for the unit. The Summerhouse is thickest, about 1,000 feet, at its type locality, but it has been completely eroded farther north (Ruppel et al., 1975).

The overlying Kinnikinic Quartzite consists of a thick bedded, white or light-gray fine- to medium-grained vitreous quartzite. It is partly mottled

with irregular lenses or blebs, commonly several inches long, of reddish-brown to reddish-orange sandstone cemented by ferrodolomite. Locally, conglomeratic zones are present at the base (Ruppel and Lopez, 1981). In the southern part of the Donkey Hills GRA, the Kinnikinic is 1,800 feet thick (Mapel and Shropshire, 1973) but it is slightly less than 1,000 feet thick in the northern part of the GRA (Ruppel and Lopez, 1981). Fossils collected from a lense of dolomite near the top of the Kinnikinic in the southern Lemhi Range indicate a Middle or Late Ordovician (450-435 m.y.) age for the Kinnikinic and include Diceromyonia sp., Glyptorthis sp. and Streptelasma sp.

The conformably overlying Saturday Mountain Formation consists of (1) a basal transition unit, about 50 feet thick, of grayish-orange to olive-gray medium-grained sandstone with thin interbeds of grayish-red to dark-gray paper shale and lenses of light-bluish gray fine- to medium-grained quartzite, all overlain by (2) a medium- to medium-light-gray, finely crystalline thick bedded to massive dolomite. Some beds contain irregular nodules and some are irregularly mottled lighter gray. An irregular network of hair-like wisps of white dolomite is present in the basal 50 feet of the dolomite unit (Ruppel and Lopez, 1981). The "wispy" dolomite along with the basal sandstone-shale-quartzite transition sequence is correlated with the Middle Ordovician Lost River Member of the Fish Haven Dolomite (Churkin, 1962). Halysites sp. is present 100 feet from the top of the unit on the south side of Hawley Mountain; thus, the upper part of the Saturday Mountain is Silurian (435-395 m.y.) (Mapel and Shropshire, 1973).

The Laketown Dolomite conformably overlies the Saturday Mountain Formation. The Laketown consists of light-olive- to medium-light-gray dolomite (Mapel and Shropshire, 1973; Ruppel and Lopez, 1981). Locally the unit has a pale-reddish tint due to disseminated iron oxide. Texturally, the Laketown is finely crystalline to medium-crystalline granular vuggy dolomite. Chert is locally present. Some beds are sandy and locally, small quartzitic lenses are present. Fossils (including Heliolites sp., Amplexus sp., Diphyphyllum sp., Favosites sp., Halysites catenulatus, Atrypa reticularis, Cyathophyllum sp. and Cladopora sp.) establish that the Laketown is in part Middle Silurian (430-410 m.y.) (Ross, 1947). An erosional unconformity is present at the top of the Laketown and the unit has been completely eroded to the north and to the east of the Donkey Hills GRA. Thickness ranges from 0 to about 500 feet (Mapel and Shropshire, 1973; Ruppel and Lopez, 1981).

The unconformably overlying Jefferson Dolomite is dominately medium dark-gray to dark-gray finely crystalline to sugary fetid dolomite. Sub-ordinate amounts of limestone, limestone sedimentary breccia, and sandstone are also present. Locally, on the pre-Jefferson unconformity, dolomitic sandstones, siltstones, shales, and minor conglomerates occur as channel deposits (Ruppel and Lopez, 1981); well-bedded silty dolomite, dolomitic shales and brecciated dolomites fill sink holes on the old erosion surface (Mapel and Shropshire, 1973). Occasionally, these basal deposits are mapped separately. Elsewhere the base of the Jefferson commonly is marked by sandstone lenses as much as 30 feet thick. Sedimentary breccias are most common in the upper part of the Jefferson (Ruppel and Lopez, 1981). A characteristic digitate form of Favosites is abundant in the lower third of the Jefferson (Ross, 1947). Late Devonian (360-345 m.y.) conodonts are

present in the upper part of the unit (Mapel and Shropshire, 1973). Thus, the Jefferson ranges from Middle Devonian (370-360 m.y.) to Late Devonian in age. Thickness is about 2,700 feet. The lower part of the Jefferson Dolomite hosts the mineralization found at Gilmore, Idaho (Ruppel and Lopez, 1981).

The Jefferson is conformably overlain by the Three Forks Formation, a medium- to dark-gray argillaceous limestone and interbedded calcareous argillite. The limestone is thin-bedded and very finely crystalline. A 5 to 10 foot thick bed of dark-gray bioclastic limestone is present at the top of the Three Forks. The Formation is non-resistant and weathers to brittle yellow chips. Thickness ranges from 150 to 300 feet (Mapel and Shropshire, 1973; Ruppel and Lopez, 1981). The Three Forks contains lenses in which fossils are abundant and well preserved. The presence of Spirifer sp., particularly Spirifer whitneyi, in these lenses indicates that the Three Forks is Late Devonian (Ross, 1947).

Early Mississippian (345-322 m.y.) rocks unconformably overlie Late Devonian rocks throughout most of Idaho (Skipp et al., 1979) including the Donkey Hills GRA. Mississippian rocks have been separated variously by different workers in the area surrounding the GRA. The following descriptions are based primarily on the division used by Mapel and Shropshire (1973) except for separation of Early Mississippian (322-310 m.y.) rocks into the McGowan Creek Formation which follows Ruppel and Lopez (1981). This hybrid classification of the Mississippian (345-310 m.y.) conforms with the regional terminology used by Skipp et al. (1979). Where possible, the unit

names used below will be related to the usage followed by other major workers in the Donkey Hills region.

The youngest Mississippian unit is the McGowan Creek Formation which regionally consists of a lower member of orogenic detritus, specifically fine-grained, thinly bedded turbidites, and an upper member of calcareous siltstone interbedded with silty micritic limestone, probably a starved-basin facies. The turbidite sequence ranges from about 100 feet in the Beaverhead Mountains to about 4,000 feet in the White Knob Mountains. The upper member of the McGowan Creek ranges in thickness from 200 to almost 500 feet and is present only north and west of Hawley Mountain (southeast corner of the Donkey Hills GRA) (Skipp et al., 1979).

In the Donkey Hills GRA the McGowan Creek Formation is a medium- to dark-gray chippy, partly carbonaceous siltstone, mudstone and shale which contains thin interbeds of pinkish- to medium-gray calcareous limestone in the upper part. Siltstone and limestone interbeds become increasingly abundant towards the top of the unit. The formation is non-resistant and the argillite in the lower part weathers to fine chips and blades.

Thickness in the Donkey Hills area ranges from 100-860 feet (Mapel and Shropshire, 1973; Ruppel and Lopez, 1981). Although the McGowan Creek is not divided into two members by existing geologic maps covering the Donkey Hills GRA, it appears from the description of the unit that both members are present. In the Lost River Range, Ross (1947) correlated basal Mississippian rocks now classified as McGowan Creek with the Milligen Formation. It is now known, however, that the McGowan Creek rocks are

younger than the rocks belonging to the Milligen Formation (Mapel and Shropshire, 1973). On the basis of conodont studies, the McGowan Creek Formation is dated as Early Mississippian.

The McGowan Creek Formation is conformably overlain by carbonate bank and forebank deposits belonging to the Middle Canyon (oldest), Scott Peak, South Creek, and Surrett Canyon Formations (youngest). These formations represent a prograding carbonate-bank complex which generally thickens westward. Thickness ranges from 1,280 to 4,225 feet (Skipp et al., 1979). The basal part of the complex, the Middle Canyon Formation, is a non-resistant calcareous sandy siltstone, and silty and sandy limestone weathering reddish brown. In the Donkey Hills GRA, the Middle Canyon ranges from 680 to 725 feet in thickness (Mapel and Shropshire, 1973) and it represents in part, the forebank deposit formed in front of the prograding bank (Skipp et al., 1979). The succeeding Scott Peak Formation (2,040 feet thick at Hawley Mountain) and the uppermost Surrett Canyon Formation (850 feet thick at Hawley Mountain), both medium- to thick-bedded medium-dark-gray to dark-gray cherty bioclastic limestone (Mapel and Shropshire, 1973), represent a carbonate-bank accumulation (Skipp et al., 1979). The intervening South Creek Formation (220 feet thick at Hawley Mountain), a thin-bedded dark-gray micritic limestone (Mapel and Shropshire, 1973) probably indicates a period of relatively deep water marine circulation that temporarily interrupted carbonate-bank buildup (Skipp et al., 1979). Fossil evidence indicates that all of the units belonging to the carbonate-bank complex are Late Mississippian in age. They are equivalent to the Brazer Limestone of Ross (1947). In the Gilmore Quadrangle the Surrett Canyon, South Creek, and part of the Scott Peak Formations have been eroded away; thus, Ruppel and

Lopez (1981) group the Middle Canyon and the remainder of the Scott Peak Formation into undivided Upper Mississippian Limestone.

North of the Snake River Plain in east-central Idaho, about 4,600 feet of interbedded carbonate rocks, sandstone, siltstone and mudstone of latest Mississippian to Early Permian (280-251 m.y.) age are assigned to the Arco Hills (oldest), Bluebird Mountain, and Snaky Canyon (youngest) Formations (Fig. 4). In the southern Lemhi and Lost River Ranges, these rocks conformably overlie the Surrect Canyon Formation (Skipp et al., 1979).

The Arco Hills Formation is composed of interbedded medium-gray, olive-gray, yellowish-brown, and grayish-red thin-bedded, argillaceous, and silty or sandy limestone, calcareous mudstone or shale, siltstone and minor sandstone, and medium- to thick-bedded pure limestone. The unit is a slope-former and is often buried beneath sandstone debris from the overlying Bluebird Mountain Formation. The upper contact with the Bluebird Mountain is sharp and is placed at the base of the stratigraphically lowest thick (12 feet or more) sandstone or siltstone bed. Brachiopods including Orbiculoidea sp., bryozoans, crinoid debris, and calcareous Foraminifera are abundant in the Arco Hills Formation. The Arco Hills is dated as Late Mississippian based on fossil evidence and stratigraphic position. Thickness in the Arco Hills area, about 45 miles southeast of the Donkey Hills is about 250 feet (Skipp et al., 1979). In the Hawley Mountain area the lower half of the Lower Pennsylvanian (310-305 m.y.) unnamed sandstone of Mapel and Shropshire (1973) probably correlates with the Arco Hills Formation (Skipp et al., 1979); thus, at Hawley Mountain the Arco Hills is about 155 feet thick.

In the southern Lost River Range, the Bluebird Mountain Formation consists of light-olive-gray, pale-yellowish-brown, and medium-light-gray, calcareous, very fine-grained, thin- to medium-bedded sandstone interbedded with medium-dark-gray sandy limestone. Some limestone beds attain thicknesses up to 15 feet. When weathered the quartzite and sandstone are moderate brown, pale yellowish brown, light olive gray, and grayish orange. The upper contact with the overlying Snaky Canyon Formation is gradational and placed at the position in the section above which limestones are dominant. Foraminifera and the conodonts, Gnathodus bilineatus and Cavusgnathus sp., indicate that the Bluebird Mountain is Late Mississippian (Skipp et al., 1979). The upper half of the Lower Pennsylvanian unnamed sandstone of Maple and Shropshire (1973) probably correlates with the Bluebird Mountain; thus, a thickness of about 150 feet is indicated at Hawley Mountain.

The Mississippian-Pennsylvanian contact is gradational in the Donkey Hills GRA, and the Pennsylvanian rocks are represented by the lower part of the recently defined Snaky Canyon Formation (Skipp et al., 1979) which is comprised of the basal Bloom Member, the succeeding Gallagher Peak Sandstone Member, and the lower part of the overlying Juniper Gulch Member. The Pennsylvanian part of the Snaky Canyon ranges from 1,970 feet thick in the Arco Hills-Howe Peak area to about 3,280 feet thick in the southern Beaverhead Mountains. The Bloom Member consists of medium-bedded gray limestone, largely sandy or silty, interbedded with thin beds of very fine-grained, yellowish-brown weathering sandstone and siltstone. Fossil evidence indicates that the Bloom Member spans Early and Middle Pennsylvanian (305-290 m.y.) time. The overlying Gallagher Peak Sandstone Member, less

than 200 feet thick, is dominately a very fine-grained calcareous sandstone. It is probably Late Pennsylvanian (290-280 m.y.) in age. The uppermost member of the Snaky Canyon Formation, the Juniper Gulch, spans the Pennsylvanian-Permian (280-230 m.y.) boundary without any major depositional change. The boundary is near the middle of the member in a 330 to 600 feet thick hydrozoan(?) algal buildup. The Juniper Gulch Member consists of interbedded sandy and cherty, generally light-gray weathering, thin- to thick-bedded limestone and dolomite. Sand and chert are most common in the basal 330 feet (Skipp et al., 1979).

The above stratigraphic division of the Pennsylvanian has not been extended into the Donkey Hills GRA by detailed geologic mapping. Mapel and Shrosphire (1973), in their mapping of the Hawley Mountain Quadrangle, split the Pennsylvanian into: (1) a basal (310 feet thick) interbedded medium-gray to medium-dark-gray bioclastic limestone and sandy limestone, and yellowish-gray calcareous fine-grained sandstone and quartzite, (2) an interval of interbedded yellowish-gray sandy limestone and fine-grained to very fine-grained calcareous sandstone (present at Taylor Mountain), and (3) a dominately medium-gray to medium-dark-gray bioclastic limestone with common brown weathering lenses and nodules of chert and interbedded partly silicified limestone. Total thickness of the three units is about 3,800 feet. As previously discussed, unit 1 is probably Late Mississippian and correlative with the Arco Hills and Bluebird Mountain Formations. The remainder of this section represents the Snaky Canyon Formation of Skipp et al. (1979).

Challis Volcanics, present along the southeastern flank of the Lost River Range and dipping 15 to 20 degrees eastward, are in angular unconformity with underlying rocks (Skipp and Hait, 1977). The major part of the volcanic complex erupted about 51 to 45 m.y. ago (Eocene). The volcanic suite ranges in composition from basaltic to rhyolitic, but is predominately andesitic to rhyodacitic in composition (Skipp, 1981). Although the number of mappable units in the Challis complex varies from place to place, they fall into three major groups based on lithology: (1) latite-andesite flows, (2) basalt and related flows, and (3) acidic tuffaceous rocks. The latite-andesite flows are moderately light colored rocks of purple, gray and green shades. Most are slightly porphyritic and some are flow-banded. Many are latite and quartz latite. The principal recognizable feldspar is alkalic plagioclase. The basalt group of rocks are reddish and nearly black flows of basalt and calcic andesite. The rocks are fine-grained with very small feldspar phenocrysts. Many of the flows are slightly amygdaloidal. Amygdules are generally filled with quartz or chalcedony, but locally contain calcite. The tuffaceous rocks are predominantly light colored, often distinctly bedded rocks composed mainly of grains from rhyolitic and latitic lava, together with detrital quartz. Locally, beds of welded tuff are present. Conglomerate is locally present within the tuffaceous rock units (Ross, 1947). Maximum thickness of the Challis Volcanics in the Donkey Hills region is about 9,500 feet in the Gilmore Quadrangle (Ruppel and Lopez, 1981).

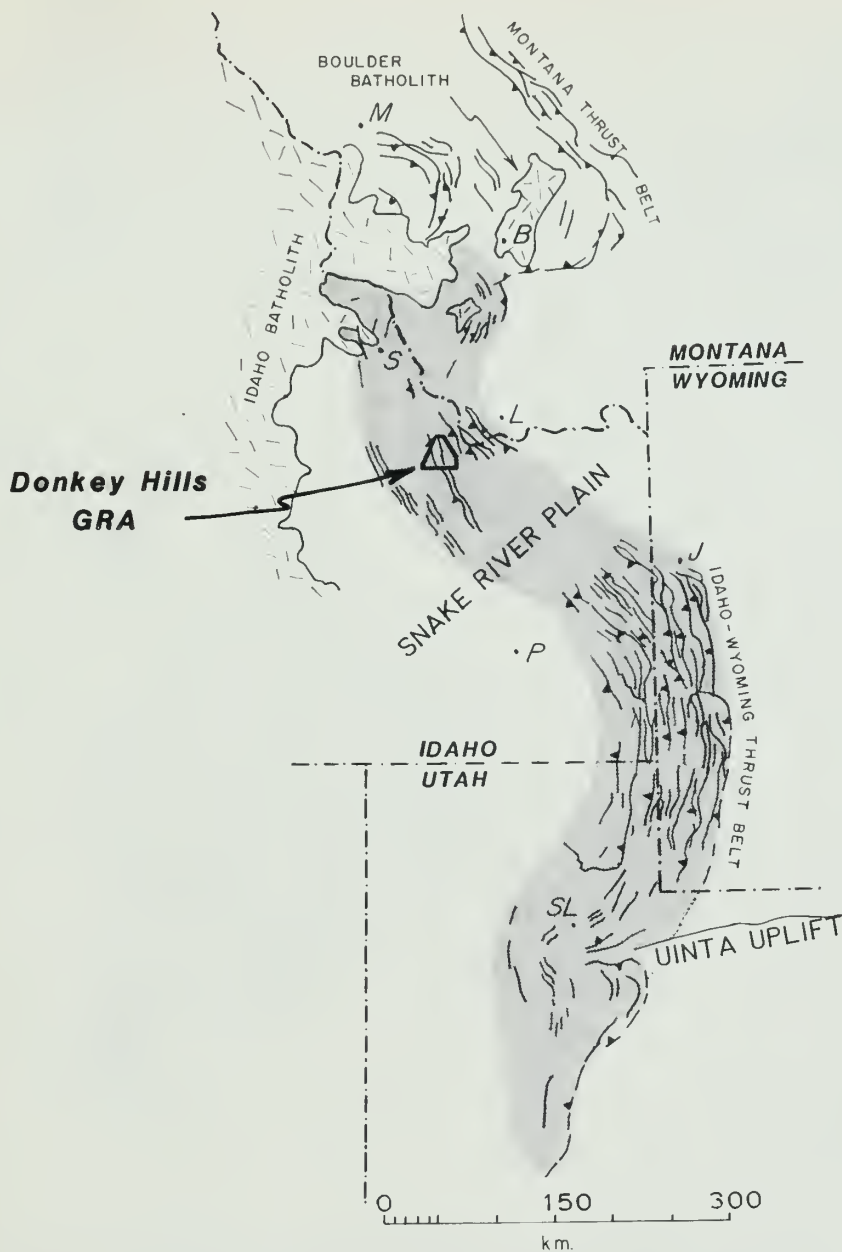
A unit named the Donkey Hills Fanglomerate consists of partially cemented alluvial material predating the alluvium of modern valleys. The fanglomerate is best exposed in the Donkey Hills. It is composed almost exclusively

of rounded to subangular, poorly sorted gravel cemented in an abundant matrix of angular pebbles, sand and dirt, held in a mixture of quartz and calcite. The material resembles caliche especially near limestone and dolomite outcrops. When fresh the fanglomerate is a firm resistant rock but the cement weathers rapidly so outcrops are rare. The fanglomerate rests on and contains pebbles of Challis Volcanics. It is covered by glacial deposits; thus, it is post-Oligocene (38-23 m.y.) and pre-Pleistocene (2-0.1 m.y.) (Ross, 1947).

A variety of Pleistocene and Holocene (0.1 m.y. to present) deposits are present including alluvium, glacial deposits, terrance gravels, pediment gravels, stream alluvium and landslide debris.

2.4 Structural Geology and Tectonics

Regionally the Donkey Hills GRA is within the frontal Sevier orogenic belt of the Cordilleran fold-thrust belt (Fig. 6). In the area northwest of the Snake River Plain and east of the Idaho batholith, a minimum of nine major allochthons are recognized including (from west to east): the Wood River, Milligen, Copper Basin, White Knob, Lost River-Arco Hills, Lemhi, Beaverhead, Medicine Lodge and Tendoy allochthons (Fig. 7). Each of these allochthons has an internally consistent stratigraphy that differs from adjacent plates. All of the allochthons, except the structurally highest Wood River, are bounded above and below by thrust faults. The allochthons can be grouped into three stacks consisting of: (1) the Pioneer or western stack, structurally the highest, comprising the Wood River, Milligen and Copper Basin allochthons, (2) the Lemhi or middle stack comprising the Lost



Structural trends in the frontal Sevier orogenic belt (stippled), Utah-Montana. Principal folds trends shown by lines; teeth on major thrust faults. M=Missoula; B=Butte; S=Salmon; L=Lima; P=Pocatello; J=Jackson; SL=Salt Lake City.

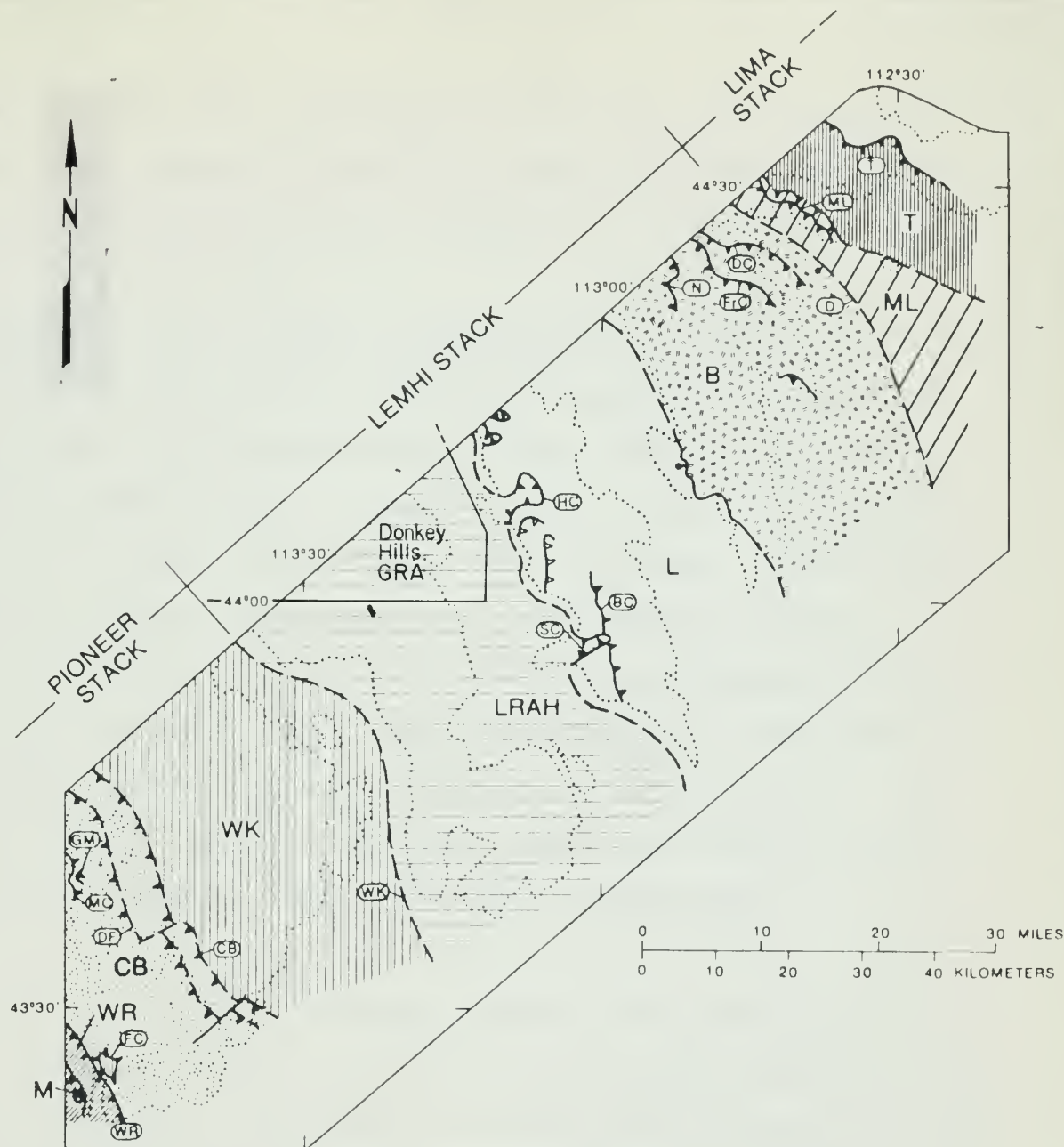
Data by: Beutner (1977)

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho
Regional Geologic Setting

SCALE AS SHOWN		FIGURE	
DATA BY	DATE 3/1983	REVISED	
DRWN BY DSI	APRVD G.F.	6	



Map showing location and extent of allochthons along northeast margin of Snake River Plain. WR = Wood River; M = Milligen; CB = Copper Basin; WK = White Knob; LRAH = Lost River-Arco Hills; L = Lemhi; B = Beaverhead; ML = Medicine Lodge (restricted); T = Tendoy and related plates. Dotted lines outline the mountain ranges (ref. fig. 3). Faults identified on map are: WR = Wood River thrust, FC = Fish Creek thrust, GM = Glide Mountain thrust, MC = Muldoon Canyon thrust, DF = Dry Fork thrust, CB = Copper Basin thrust, WK = White Knob thrust, SC = South Creek thrust, HC = Horse Creek thrust, BC = Black Canyon thrust, N = Nicholas thrust, FrC = Fritz Creek thrust, DC = Divide Creek thrust, D = Deadman normal fault, ML = Medicine Lodge thrust, T = Tendoy thrust.

WGM Inc. Mining and Geological Consultant
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2, NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho Structural Setting

SCALE: AS SHOWN

DATA BY: WGM DATE: 3-1993

DRAWN BY: GSI APRVD: F

FIGURE

7

River-Arco Hills, Lemhi, and Beaverhead allochthons, and (3) the Lima or eastern stack, structurally the lowest, comprising the Medicine Lodge and Tendoy allochthons (Skipp and Hait, 1977).

The Donkey Hills GRA is within the Lemhi stack of allochthons (Fig. 7). The allochthons in the Lemhi stack contain thick sequences of Precambrian Y rocks overlain locally by Precambrian Z rocks. The Precambrian rocks are overlain by thick Paleozoic miogeoclinal sequences which exhibit a general resemblance to each other from allochthon to allochthon. The Lemhi stack is underlain by a major thrust zone within the Precambrian Y sequence.

Preliminary tectonic reconstructions indicate a total movement of 125 to 150 miles, but relative movements between the Lost River-Arco Hills, Lemhi and Beaverhead allochthons appears to be small (Skipp and Hait, 1977). The boundary between the Lost River-Arco Hills and Lemhi allochthons passes through the northeastern edge of the Donkey Hills GRA (Fig. 7).

The Lost River-Arco Hills allochthon encompasses the southern part of the Lost River Range, the Arco Hills and two "slide" blocks on the western side of the Lemhi Range. It is about 22 miles wide at the surface and more than 6,200 feet thick. Rocks ranging in age from Precambrian Y to Permian are exposed in the Lost River-Arco Hills allochthon. These rocks are unconformably overlain by the Challis Volcanics. The allochthon is broken by several major basin and range faults, with displacements of as much as 20,000 feet, which have tilted the resulting blocks eastward. The 15 to 20 degree dip on the Challis Volcanics gives an indication of the amount of eastward tilting. The Lost River-Arco Hills allochthon is additionally cut by east-trending

normal faults and, in the southernmost part, by westward curving faults. These fault systems are cut by still active range-front normal faults along which the Lost River Range and the Arco Hills have been elevated and tilted to the east (Skipp and Hait, 1977).

The Lemhi allochthon (Fig. 7) is about 15 miles wide at the surface extending from the range-front fault on the west side of the Lemhi Range northeast to the range-front fault on the west side of the Beaverhead Mountains. The allochthon includes the down-faulted Blue Dome block and an imbricate thrust zone on the west side of the Beaverhead Mountains. Unlike the Lost River-Arco Hills allochthon, the Lemhi is demonstrably imbricate. The thickness of the Lemhi allochthon is 6,000 feet, and strata exposed within the allochthon range from the Precambrian Y Lemhi Group to the Permian Phosphoria Formation. Challis Volcanics unconformably overlie the Paleozoic rocks. Later structural development of the Lemhi allochthon is similar to that of the Lost River-Arco Hills allochthon (Skipp and Hait, 1977).

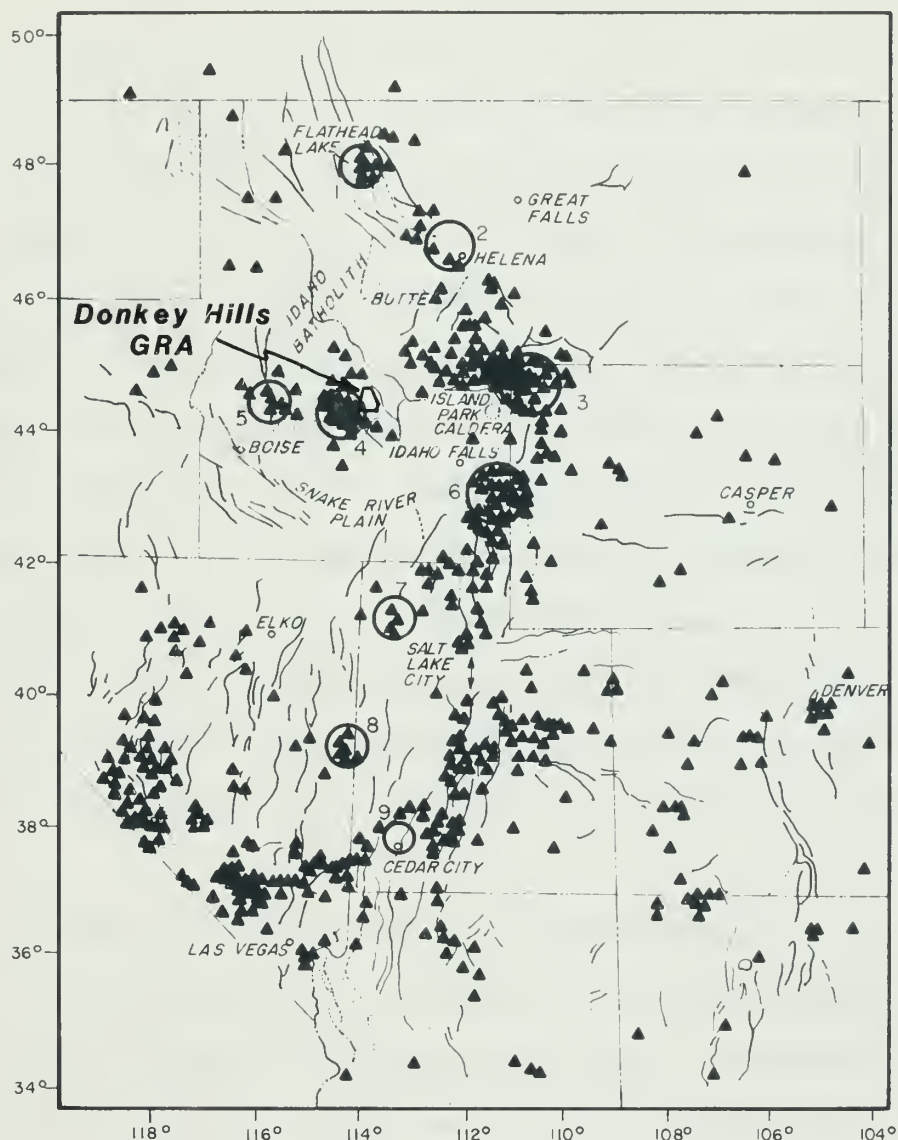
In the Donkey Hills GRA Precambrian rocks have been arched into broad folds with minor local crenulations. Their average strike is due north with most dips averaging 40° to the east. The Paleozoic strata are more intensely folded. These folds typically are close-spaced with northwest trends, and most are overturned toward the northwest. Thus, the Precambrian rocks appear to have acted as a buttress against which the less competent Paleozoic rocks impinged (Ross, 1947).

Numerous thrust faults with small displacement and steep dips are associated with folding. They are visible in nearly every exposure of an asymmetric anticline and trend northwest and dip up to 75° southwest (Ross, 1947).

The Donkey Hills GRA is within the Intermountain Seismic Belt (Fig. 8) and lies immediately adjacent to the Sawtooth Range, Idaho earthquake swarm (Smith and Sbar, 1974). Consequently, earthquakes are a major geologic hazard in the GRA.

2.5 Paleontology

Although rocks underlying the Donkey Hills GRA are locally moderately fossiliferous, no unique fossil collecting sites are reported. The Summerhouse Formation has yielded conodont collections at several localities and trilobites and brachiopods occur in the Summerhouse at its type locality (Ruppel, 1975). Ross (1947) describes six collections of fossils, predominately brachiopods and Streptelasma sp., from several localities in the Saturday Mountain Formation. Halysites sp. and some brachiopods occur in the Saturday Mountain Formation at Hawley Mountain (Mapel and Shropshire, 1973). Several species of rugose corals have been collected by the U.S. Geological Survey from the Laketown Dolomite at Borah Peak and in the Donkey Hills (Ross, 1947). The Jefferson Formation contains the Late Devonian conodonts, Palmatolepis gigas, at Hawley Mountain (Mapel and Shropshire, 1973). Articulate brachiopods occur in fossiliferous lenses in the Three Forks Formation and several collections of these from the Borah Peak area are described by Ross (1947). No fossils localities are reported within the Donkey Hills GRA for post-Devonian rocks.



EPICENTERS FOR INTERMOUNTAIN SEISMIC BELT SHOWING ALL EARTHQUAKES REPORTED BY NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) OF ABOUT MAGNITUDE 3.0 OR GREATER FROM 1961 THROUGH 1970. DOUBLE ARROW SHOWS ZONE OF LOW SEISMICITY. CIRCLES MARK EARTHQUAKE SWARMS: 1, FLATHEAD LAKE, MONT.; 2, HELENA, MONT.; 3, YELLOWSTONE PARK; 4, SAWTOOTH RANGE, IDAHO; 5, IDAHO BATHOLITH; 6, CARIBOU RANGE, IDAHO; 7, GREAT SALT LAKE DESERT, UTAH; 8, LEHMAN CAVE MONUMENT, NEVADA; 9, CEDAR CITY, UTAH.

DATA FROM SMITH AND SBAR (1974)

0 70 140 210 MILES
SCALE APPROXIMATE

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho Regional Seismicity

SCALE AS SHOWN		FIGURE 8
DATA BY	DATE 1/1983	
DRWN BY DSI	APPRD GF	

2.6 Geologic History

During Precambrian Y time, the Donkey Hills GRA was located on a high area separating the Belt Basin in northern Idaho and northwestern Montana from the Cordilleran Miogeocline. The sediments comprising the Lemhi Group rocks were deposited in the miogeocline 150 to 200 miles southwest of the Donkey Hills. The change from fine-grained feldspathic quartzite in the Gunsight Formation to medium-grained, hematitic, non-feldspathic quartzite in the Swauger Formation may reflect the major tectonic adjustments of early Missoula time (Ruppel, 1975). The pronounced unconformity between the Swauger Formation and the overlying Precambrian Z Wilbert Formation reflects major deposition and erosion of the Precambrian Y rocks. Regional uplift, folding, and some faulting ended sedimentation in the Precambrian Y miogeocline, and is probably closely related to deformation associated with the East Kootenay orogeny in Canada about 800 m.y. ago (Ruppel et al., 1975).

The Precambrian Z Wilbert Formation was deposited in a near-shore environment. The northward thinning recognizable in the Lemhi Range reflects both on-lap and Late Cambrian emergence and erosion. The shoreline was probably at least 100 miles west of the Donkey Hills GRA (Rupel et al., 1975).

Formerly, south-central Idaho was thought to have been a relatively stable miogeosynclinal area during early Paleozoic time, but evidence of an Ordovician disturbance is accumulating (Skipp, 1981). The Early Ordovician Summerhouse Formation represents a near-shore perhaps lagoonal environment. The Summerhouse is overlain in slight angular unconformity by the Kinnikinic

Quartzite (Ruppel et al., 1975) which indicates a period of emergence and folding. In addition, an intrusive complex in the southern Beaverhead Mountains is dated as latest Early Ordovician and syndepositional faulting in the Kinnikinic Quartzite is described in the same area (Skipp, 1981).

From the Middle Ordovician through Silurian the Donkey Hills GRA was encompassed by the Lemhi arch, a northwest-trending intermittently emergent landmass that separated the Cordilleran miogeocline in western Idaho from a shelf embayment in southwestern Montana. During this time, the eastern side of the arch was probably continuous with the large landmass to the east since Ordovician and Silurian rocks are absent in Montana (Ruppel, 1978). The Middle Ordovician through Silurian rocks in the Donkey Hills GRA are characteristic of a shallow, very gradually deepening sea. The Kinnikinic, a near-shore clean sand, probably derived from a mature landmass to the east, is succeeded by reefal dolomites (Ross, 1947). Sometime toward the end of Silurian or beginning of Early Devonian the seas withdrew and a widespread erosion surface developed, exposing successively older rocks (from Silurian to Cambrian) in an easterly direction (Scholten and Hait, 1962).

Beginning in Middle Devonian a deep basin developed in central Idaho. To the east a miogeosyncline developed which eventually became distinctly differentiated from the semi-stable cratonic shelf along a sharp hinge line near the present Lemhi Range. Seas were regionally transgressive during all of Middle and part of Late Devonian time (Scholten and Hait, 1962).

Latest Devonian to early Mississippian was a period of upheaval associated with the Antler orogeny. Devonian and older rocks were uplifted and eroded as the Antler highland developed in southwestern Idaho and northern Nevada (Skipp, 1981). Turbidites filled a deep and narrow flysch trough developed adjacent to the eastern margin of the Antler highland. East of the flysch trough, thick orogenic, thin starved-basin, and thick carbonate sequences were deposited in an outer cratonic platform or foreland basinal environment. Sedimentation continued without major interruption through Mississippian time (Skipp et al., 1979). The flysch basin had filled by Early Pennsylvanian time and was succeeded by a carbonate bank. Coincident with the rise of the ancestral Rocky Mountains during Middle Pennsylvanian time, the sediments in the western portion of the flysch basin were uplifted to form the Copper Basin highland. Minor coarse detritus from this highland was shed eastward into the shallow water carbonate bank regime of the Snaky Canyon Formation (Skipp, 1981).

The time gap between Permian rocks and the Eocene Challis Volcanics represents the Sevier orogeny. During Early Cretaceous to Paleocene the major thrust sheets developed forming the allochthonous terrane presently underlying the Donkey Hills GRA (Skipp, 1981). Eastward telescoping due to thrusting across the northeast margin of the Snake River Plain is estimated to have produced crustal shortening in excess of 180 miles, and possibly as much as 400 miles (Skipp and Hait, 1977).

The major part of the Eocene Challis Volcanics was erupted from about 51 to 45 m.y. ago. Minor volcanism and associated intrusive activity continued in the south-central Idaho region until about 40 m.y. ago. Normal and strike-

slip faulting preceeded and accompanied volcanism (Skipp, 1981).

After a relatively tectonically inactive period during Oligocene (38-23 m.y.) and early Miocene (23-6 m.y.), major basin-and-range extension faulting commenced about 17 m.y. ago. Eastward tilting of the uplifted fault blocks along moderately dipping normal faults located on their west flank formed the narrow, linear north- to northwest-trending mountain ranges (Skipp, 1981). Erosion of the mountain ranges resulted in deposition of Tertiary and Quaternary detrital deposits present in the Donkey Hills GRA.

3.0 ENERGY AND MINERAL RESOURCES

Compilations of known mineral occurrences in the Dubois Quadrangle include Mitchell et al. (1981) and the computer printouts available for the quadrangle through the U.S. Bureau of Mines' Mineral Industry Location System (MILS). The only specific description of mineral occurrences within the Donkey Hills GRA are in Ross (1947). Descriptions of nearby deposits which may be similar to some of the occurrences in the GRA include an account on the Ima mine by Bradshaw (1980) and a U.S. Geological Survey open-file report on the Gilmore district (Ruppel et al., 1970). WGM personnel spent one day in the area visiting the Ima mine and the Big Creek prospect. They also collected silt samples from streams draining the Goldburg WSA.

3.1 Known Mineral and Energy Deposits

There are no known mineral deposits within the Donkey Hills GRA. Several borrow (sand) pits are reported in Thousand Springs Valley, just outside the southwestern corner of the GRA (Mitchell et al., 1981). No details are available on any of these sand and gravel occurrences, but most likely they are mined on an as-needed basis for local road construction and repair.

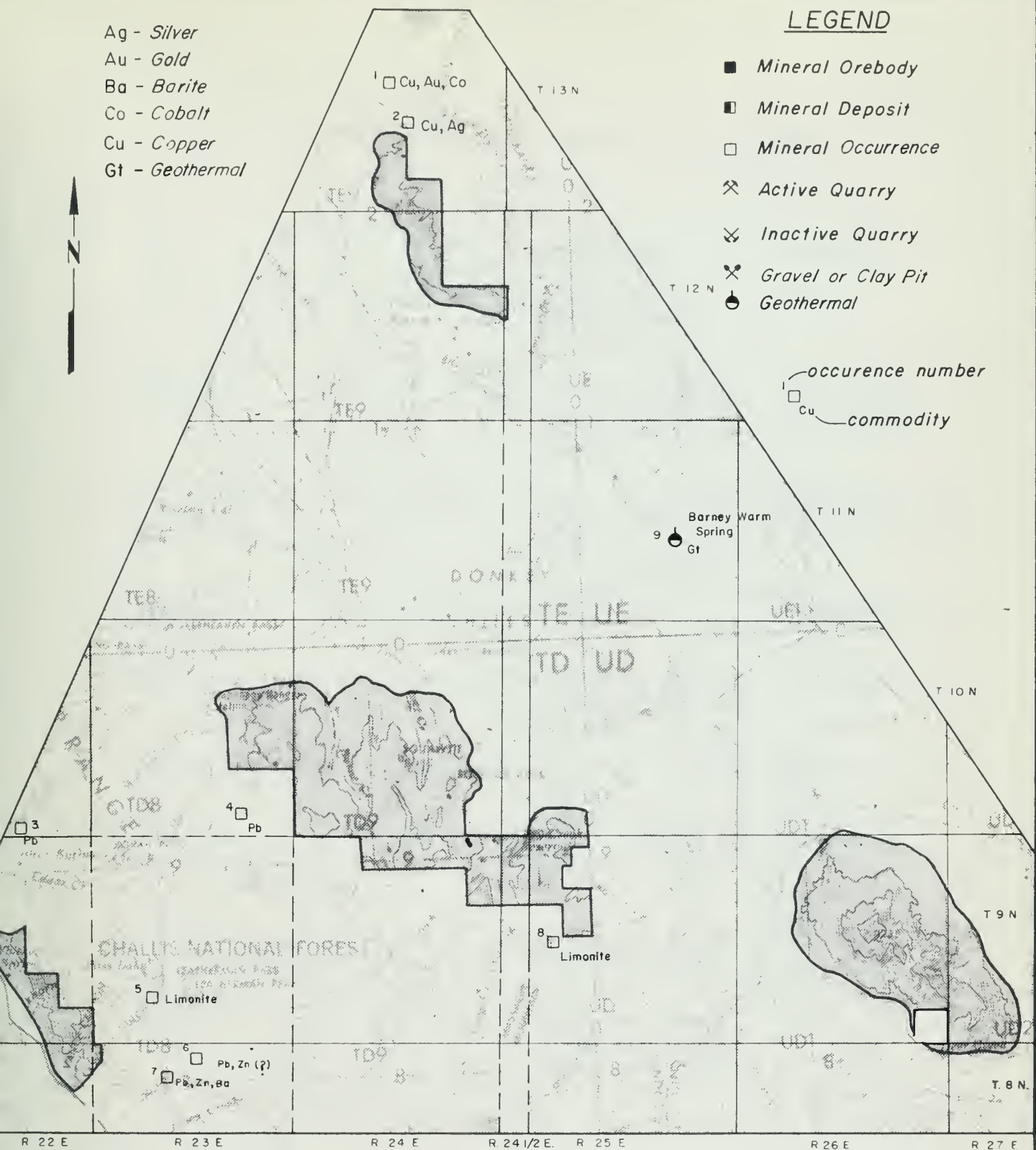
The only known energy resource in the Donkey Hills GRA is Barney Warm Spring (loc. 9, Fig. 9, Table I) in the Little Lost River Valley. The warm spring has a discharge of 643 liters per minute at 28°C. Its maximum discharge temperature is 59°C. The controls on the location of Barney Warm Spring are not known.

Ag - Silver
 Au - Gold
 Ba - Barite
 Co - Cobalt
 Cu - Copper
 Gt - Geothermal

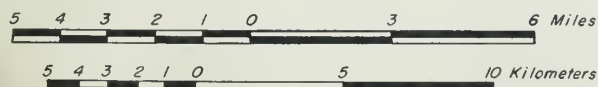
LEGEND

- Mineral Orebody
- ▣ Mineral Deposit
- Mineral Occurrence
- ⌵ Active Quarry
- ⌵ Inactive Quarry
- ⌵ Gravel or Clay Pit
- Geothermal

□ occurrence number
 Cu commodity



Approximate Boundary of Wilderness Study Area.



WGM Inc. Mining and Geological Consultants
 Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
 REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho Mineral and Energy Occurrences

SCALE 1" = 4 MILES (1:250000)

DATA BY WGM DATE 1/1983

DRWN BY DSI APRVD G.F.

REVISED

FIGURE

9

TABLE I

MINERAL AND ENERGY PROSPECTS AND OCCURRENCES IN THE DONKEY GRA, IDAHO

Map No. ¹	Name	Location			Description	Reference
		Sec.	T.	R.		
1	Wells Prospect	16	13N	24E	Copper, gold, cobalt, nickel and silver	MILS
2	Big Creek Prospect	21- 22	13N	24E	Contact metasoma- tic copper and silver mineral- ization	Ross, 1947; Appendix II - this report
3	Mt. Borah Prospect	34	10N	22E	Galena and possibly sphalerite in frac- tured and silici- field dolomite	Mitchell et al., 1981; Ross, 1947
4	Ben Lyon Prospect	35	10N	23E	Galena?	Mitchell et al., 1981
5	Jayrock	29	9N	23E	Limonite along dolomite-quartzite contact	Ross, 1947
6	Unnamed	4	8N	23E	Galena(?), sphaler- ite(?)	Mitchell et al., 1981
7	Lone Cedar Creek Prospects	8	8N	23E	Barite, galena, and sphalerite in dolo- mite	Ross, 1947
8	Unnamed	19	9N	25E	Limonite in frac- tured limestone	Ross, 1947
9	Barney Warm Spring	23	11N	25E	Discharge of 643 liters per minute at 28°C. Maximum temperature of 28°C.	Mitchell et al.,

1. Refer to Figure 9.

3.2 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas

Two prospects, the Wells (loc. 1, Fig. 9, Table I) and the Big Creek (loc. 2, Fig. 9, Table I) prospects, occur within Precambrian metasediments in the northernmost part of the Donkey Hills GRA. The Wells prospect is cited in the U.S. Bureau of Mines MILS compilation for the Dubois Quadrangle. Underground development of the prospect is reported and mineralization reportedly contains copper, gold, cobalt, nickel and silver. No other information on the prospect is available. The Big Creek prospect is located on the north side of Big Creek and consists of several cuts and short tunnels which follow stringers and veinlets localized in the contact zone between the Gunsight Formation and a small quartz diorite pluton. Tetrahedrite, specular hematite, and chalcopyrite occur in the veins (Ross, 1947). Observations made by WGM geologists during a visit to the Big Creek prospect confirm the above description. In addition to the minerals reported by Ross, pyrite was observed and the mineralization was noted to be disseminated along the contact between sheared, hornfelsed quartzite and quartz diorite.

Several lead or lead/zinc prospects (locs. 3, 4, 6 and 7; Fig. 9; Table I) are known in the southwestern part of the Donkey Hills GRA. Ross (1947) describes the Lone Cedar Creek prospects (loc. 7, Fig. 9, Table I) and a group of prospects east of Willow Creek which probably includes the Mt. Borah prospect (loc. 3, Fig. 9, Table I). Prospects in both areas are in northerly to northwesterly trending veins in fractured and silicified Jefferson Dolomite. The veins east of Willow Creek dip 60°SW whereas the veins near Lone Cedar Creek dip steeply northeast. East of Willow Creek, mineralization consists of galena whereas quartz, calcite, barite, galena

and sphalerite are reported in the Lone Cedar Creek prospects. No information other than that shown on Figure 9 and in Table I is known about the Ben Lyon prospect (loc. 4). Presumably, it is similar to the other lead and lead/zinc occurrences discussed above.

The Jayrock prospect (loc. 5, Fig. 9, Table I) and an unnamed prospect (loc. 8, Fig. 9, Table I) both consist of pits on limonite showings. At the Jayrock prospect, a limonite zone striking N20°E and dipping 70°NW occurs along the contact between rusty, pitted quartzite and dark dolomite. Vein quartz is also present. The prospect is probably in the Kinnikinic Quartzite where associated dolomitic beds often contain conspicuous amounts of limonite (Ross, 1947). Thus, the mineralization at the Jayrock is probably not significant. The mineralization at the unnamed prospect (loc. 8) consists of limonite in fractured Mississippian limestone (Ross, 1947). The economic significance of the showing depends upon whether or not the limonite was derived from weathering of non-ferrous base metal sulfides.

No energy prospects or occurrences are known in the Donkey Hills GRA.

3.3 Mining Claims, Leases and Material Sites

A review of BLM claim records current to June 7, 1982 shows that there are no patented claims and 115 unpatented mining claims in the Donkey Hills GRA (Fig. 10). Many of the claims cover occurrences discussed in Section 3.2 but there are 41 unpatented claims in T.12N., R.25E., an area underlain by the Swauger Formation, and 34 unpatented claims in sec. 30, T.9N., R.25E., an area apparently underlain by Mississippian limestones. Three claims in

FIGURE
10

the central part of T.9N., R.25E. are underlain by Challis Volcanics. None of the claims are within the four WSAs.

About 80% of the Donkey Hills GRA is covered by oil and gas leases or lease applications (Fig. 11). General coverage within the four WSAs is summarized below and details on the leases covering the WSAs is given in Table II.

SUMMARY OF OIL AND GAS LEASE DISTRIBUTION IN DONKEY HILLS WSAs

<u>WSA</u>	<u>Area Leased</u>	<u>Area Covered by Lease Applications</u>	<u>Area Open (%)</u>
Goldburg (45-1)	All		0
Burnt Creek (45-12)	All T.10N., R.24E. except S $\frac{1}{2}$ sec. 9 and sec. 16. All in Ts.9-10N., R.25E.	All in T.10N., R.23E.	20
Hawley Mountain (32-3)	All except secs. 25-27, 35, T.9N., R.26E.; sec. 1, T.8N., R.26E.; and sec. 6, T.8N., R.27E.	Secs. 25-27, 35, T.9N., R.26E., sec. 1, T.8N., R. 26E., sec. 6, T.8N., R.27E.	10
Borah Peak (47-4)	All except sec. 36, T.9N., R.22E.		15

No material sites exist within the Donkey Hills GRA.

3.5 Mineral and Energy Deposit Types

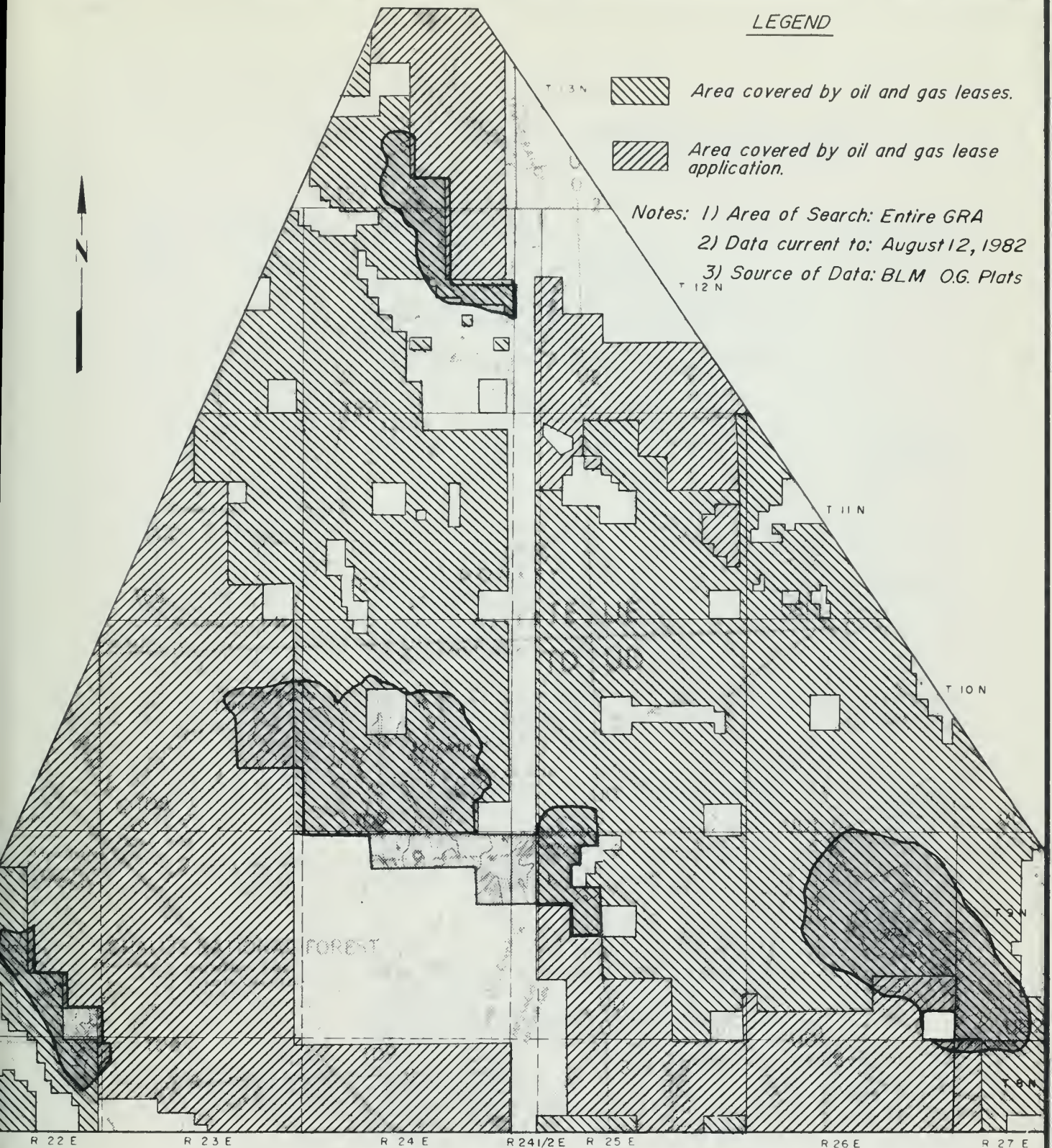
At least two types of mineralization are present in the Donkey Hills GRA:

- (1) contact metamorphic and vein deposits of base and precious metals, and
- (2) lead-zinc-barite mineralization in carbonate rocks. The Wells prospect

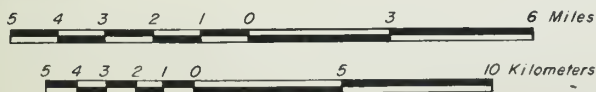
LEGEND

-  Area covered by oil and gas leases.
-  Area covered by oil and gas lease application.

Notes: 1) Area of Search: Entire GRA
 2) Data current to: August 12, 1982
 3) Source of Data: BLM O.G. Plats



 Approximate Boundary of Wilderness Study Area.



WGM Inc. Mining and Geological Consultants
 Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
 REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho

Oil and Gas Lease Status

SCALE 1" = 4 MILES				FIGURE 11
DATA BY	WGM	DATE	1/1983	
DRWN BY	DSI	APRVD	G.F.	

TABLE IIOIL AND GAS LEASES IN THE DONKEY HILLS GRA, IDAHO

<u>WSA</u>	<u>Lease No.</u>	<u>Owner of Record</u>	<u>Date Issued</u>
32-3	I 11769	Sarah Anderson, Assignee 3% Joseph C. Anderson, Assignee 3% Donald B. Anderson, Jr., Assignee 3% Donald B. Anderson Ltd. a General Partnership, Assignee 91% P.O. Box 1 Roswell, New Mexico 88201	12-01-81
	I 11771	Same as Lease # I 11769	02-01-77
	I 13688	?	?
	I 13689	?	?
	I 14179	Cabot Petroleum Corporation 921 Main Street Suite 900 Houston, Texas 77002	10-01-80
	I 16829	North American Resources Company 40 East Broadway Butte, Montana 59701	04-22-82
	I 17146	Sanchez-O'Brien Oil & Gas Corporation P.O. Box 2986 Laredo, Texas 78041	12-16-80 (applic. filed)
	I 17151	Same as #I 17146	12-16-80 (applic. filed)
	I 17315	Great Eastern Energy and Development Corporation 701 East Byrd Street, Suite 2100 Richmond, Virginia 23219	10-81
	I 17795	Thomas D. Hewitt 915 Gulf Canada Sq. Calgary, Alberta, Canada T2D 3C5	04-22-82
45-1	I 17147	Sanchez-O'Brien Oil & Gas Corporation P.O. Box 2986 Laredo, Texas 78041	12-16-80 (applic. filed)

<u>WSA</u>	<u>Lease No.</u>	<u>Owner of Record</u>	<u>Date Issued</u>
45-1	I 17217	Robert C. Balsam 1/8 interest John R. Warne 3/8 interest Irvin Kranzler 3/8 interest Carl B. Field 1/8 interest Box 1324 Billings, Montana 59103	03-01-82
	I 17690	Lear Petroleum Exploration Inc. 5990 S. Syracuse, Suite 110 Englewood, Colorado 80111	11-01-81
	I 17738	?	?
	I 17772	Lear Petroleum Exploration Inc. 5990 S. Syracuse, Suite 110 Englewood, Colorado 80111	12-01-81
	I 18056	Great Eastern Energy & Development Corporation 1625 Broadway, Suite 520 Denver, Colorado 80202	03-01-82
45-12	I 17142	Sanchez-O'Brien Oil & Gas Corporation P.O. Box 2986 Laredo, Texas 78041	11-01-82
	I 17145	Same as #I 17142	11-01-82
	I 17176	Thomas D. Hewitt 915 Gulf Canada Sq. Calgary, Alberta, Canada T2D 3C5	11-01-81
	I 17301	Great Eastern Energy & Development Corporation 1625 Broadway, Suite 520 Denver, Colorado 80202	02-03-81 (applic. filed)
	I 17309	Great Eastern Energy & Development 701 East Byrd Street, Suite 2100 Richmond, Virginia 23219	12-01-81
	I 17310	Same as #I 17309	09-01-81
	I 17311	Same as #I 17309	09-01-81
	I 17317	Same as #I 17309	02-04-81 (applic. filed)
	I 17773	Lear Petroleum Explorations Inc. 5990 S. Syracuse, Suite 110 Englewood, Colorado 80111	12-01-81

<u>WSA</u>	<u>Lease No.</u>	<u>Owner of Record</u>	<u>Date Issued</u>
47-4	I 16568	Ronan Inc. P.O. Box 1354 Billings, Montana 59103	12-01-81
	I 16627	Same as #I 16568	11-01-81
	I 17330	Great Eastern Energy & Development Corporation 1625 Broadway, Suite 520 Denver, Colorado 80202	02-03-81 (applic. filed)
	I 17800	Same as #I 17330	06-26-81 (applic. filed)
?	I 17183	?	? (applic. filed)
?	I 17293	?	? (applic. filed)

may constitute a third class, replacement cobalt and copper mineralization in metasediments.

The geologic setting of the Big Creek prospect is similar to that of the Ima mine on Patterson Creek about 4.5 miles northwest of the Donkey Hills GRA. At the Ima, a tungsten-copper-molybdenum-silver vein system is associated with the Ima stock (Bradshaw, 1980), a coarse-grained biotite granite of Eocene age (Ruppel, 1980). The stock intruded flat-lying fault blocks of argillaceous quartzite and siltite belonging to the Lemhi Group. Mineral assemblages indicate that molybdenum mineralization occurred first relative to tungsten mineralization. The molybdenum stage is characterized by molybdenite, chalcopyrite, scheelite, and pyrite and is zoned relative to distance from potassic alteration. A transitional stage, either slightly later or farther from the mineralizing source, contains lesser amounts of the minerals characterizing the molybdenum stage plus minor amounts of hubnerite, sphalerite, galena, and fluorite. The tungsten stage consists of more abundant hubnerite along with tetrahedrite, pyrite, and subordinate amounts of sphalerite and galena. The tungsten mineralization occurs within and adjacent to the potassic alteration zone and extends as much as one mile away from the intrusive. Tungsten-rich veins have phyllic alteration envelopes and within the intrusive they have a sericite-rich envelope overprinted upon earlier potassic-phyllic alteration. Deep drilling has disclosed the presence of disseminated molybdenite within a potassic altered phase of the Ima stock (Bradshaw, 1980).

The lead-zinc occurrences in the Jefferson Dolomite might indicate potential for deposits similar to those at Gilmore, about 15 miles east of the Donkey

Hills GRA, or for Mississippi Valley-type mineralization. At Gilmore lead-silver orebodies occur in fracture zones parallel in strike but opposite in dip to the dolomite host rock. Vein mineralization consists of quartz and simple sulfides (Ross, 1941). The host dolomite belongs to the lower Jefferson Dolomite (Ruppel and Lopez, 1981). The principal deposits appear to be associated with a stock intruded along the flank of an uplifted mountain block (Ruppel, 1982). Unlike Gilmore, no intrusive rocks are exposed around the lead-zinc showings in the Donkey Hills GRA, although they could be present at depth. Another possibility, however, is that the Jefferson Dolomite is a favorable host rock for Mississippi Valley-type mineralization. Mississippi Valley-type mineralization is characterized by the following:

1. simple sulfide mineralogy
2. generally hosted by dolomites, less commonly by sandstones or limestones
3. absence of nearby intrusive rocks
4. mineralization related to local face changes in host rock
5. districts related to basinal margins

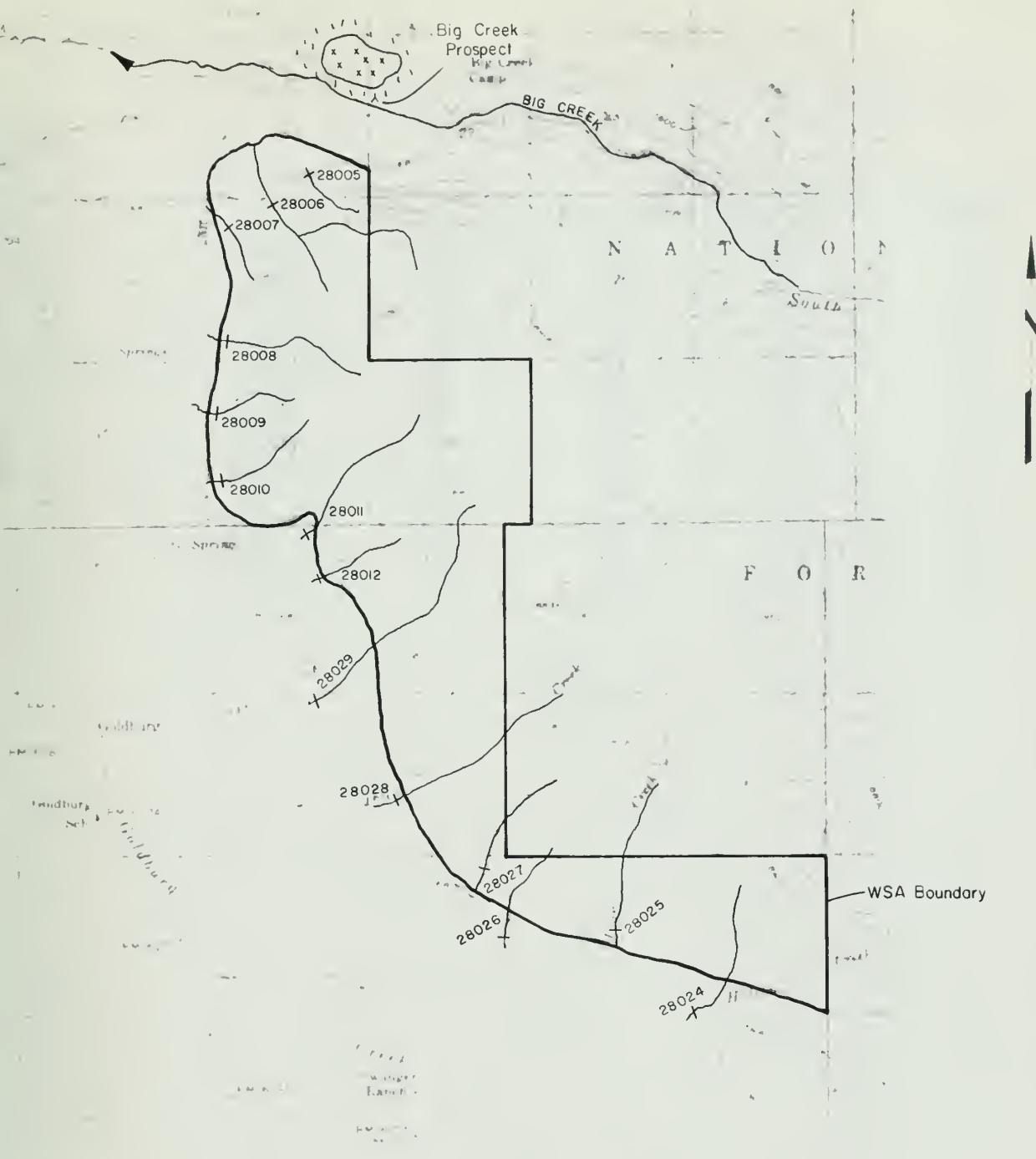
Although the allochthonous nature of the terrane within the Donkey Hills GRA obscures the facies relationship among the sediments, both breccias and reef complexes, which are excellent ore hosts elsewhere, appear to be present in the Devonian carbonates. If Mississippi Valley-type lead-zinc mineralization is present in the area, then the known lead-zinc occurrences may represent remobilization of the mineralization during later geologic

processes (ground water migration along fractures in the southwestern Donkey Hills GRA and igneous intrusion at Gilmore).

Although speculative due to the paucity of data, the Wells prospect could be similar to the mineralization in the Blackbird mine area, east-central Idaho, where disseminated replacement deposits in Precambrian metasediments contain 1.6% copper, 0.6% cobalt and lesser amounts of nickel and precious metals (Vhay, 1948). The host rocks are probably correlative with the Precambrian sediments in the Donkey Hills GRA. In the Blackbird district the host rocks are tightly folded and orebodies occur as elongate lenses controlled by the axes of northerly plunging folds. Cobaltite, safflorite, chalcopyrite, pyrite, and native bismuth are the primary ore minerals (Hobbs, 1968).

During a visit by WGM geologists to the Big Creek prospect, 14 stream silt samples were collected from streams draining the Goldburg WSA (Fig. 12). Analytical results (Table III) ranged from 20 to 35 ppm for copper, 25 to 90 ppm for zinc, less than 2 to 4 ppm for molybdenum, and was 5 ppm or less for cobalt. Although these results are not encouraging, negative geochemistry does not provide conclusive evidence of unmineralized terrain without supporting evidence. Potential may still exist for blind deposits below the subcrop surface.

Green (1972) plotted the locations of mineral occurrences in central Idaho and found that many of them were located within four prominent belts (Fig. 13). The southern extent of one of these belts, the Florence-Stibnite belt is unknown, but it could extend into the southwestern portion of the Donkey



WGM Inc. Mining and Exploration

BLM GEM RESOURCES ASSESSMENT
 SECTION 2 NORTH HERNANDEZ MOUNTAINS

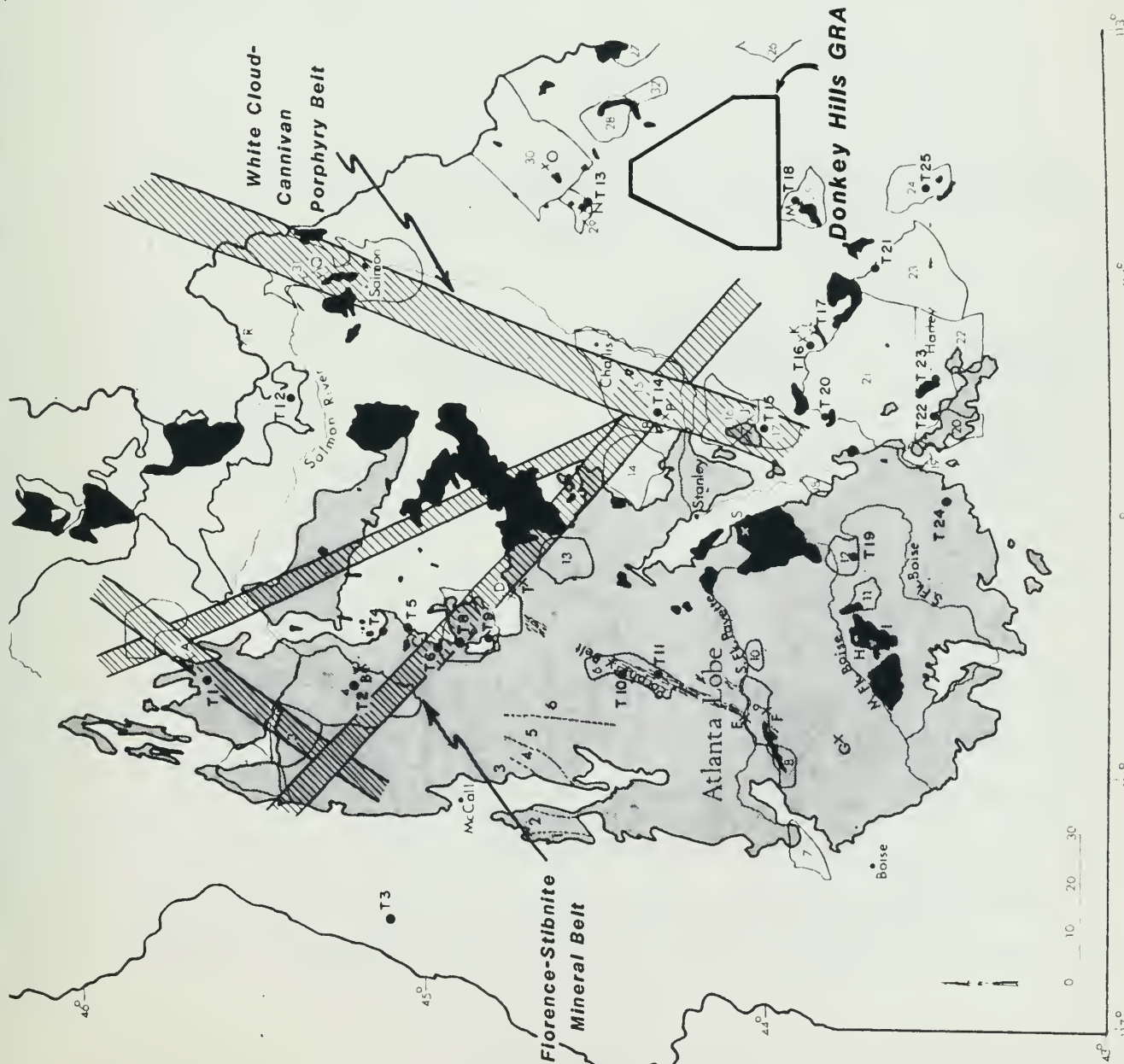
**Donkey Hills GRA, Idaho
 Geochemical Sample
 Locations
 Goldberg WSA**

1" = 1 MILE

TABLE IIIANALYTICAL RESULTS FROM STREAM SILT SAMPLES - GOLDBURG WSA

Sample No.	Element			
	Cu (ppm)	Zn (ppm)	Mo (ppm)	Co (ppm)
28005	30	75	<2	5
28006	20	30	<2	<5
28007	30	80	2	5
28008	25	55	<2	<5
28009	30	75	<2	5
28010	30	90	<2	5
28011	30	80	<2	<5
28012	30	75	<2	<5
28024	20	30	4	<5
28025	35	70	<2	<5
28026	25	45	<2	<5
28027	25	65	<2	<5
28028	20	25	2	<5
28029	30	50	<2	<5

- X^A MOLYBDENUM DEPOSIT OR OCCURRENCE
- T³ TUNGSTEN OCCURRENCE OR DISTRICT
- 7 MINING DISTRICT
- MINERAL BELT. from: (Green, 1972).
- IDAHO BATHOLITH
- TERTIARY INTRUSIVE



40° 117° 116° 115° 114° 113°

Data from: Bennett (1980), Kiilsgaard (1964), Armstrong, et.al. (1978), and Green (1972).

Molybdenum occurrences: A. Petsite prospect; B. Sour Fork prospect; C. Profile var mine; D. Virginia Beth prospect; E. Little Falls prospect; F. Cuno prospect; G. Morning Mist prospect; H. Rinebold prospect; I. Becker-Horstenstein prospect; J. Little Boulder Creek; (White Cloud prospect; K. Walton prospect; L. White Mountain prospect; M. Empire mine; N. Ima mine; O. Blue Jay mine; P. Thompson Creek; Q. Napoleon Hill; R. Spring Creek prospect; S. Sawtooth batholith; T. Moliv mine group.

Tungsten occurrences and districts: T1. Tenable district; T2. Warren district; T3. Seven Devils district; T4. Big Creek district; T5. Profile Gap; T6. Quartz Creek; T7. Overbill; T8. Yellow Pine; T9. Springfield; T10. Deadwood district; T11. White Hawk Meadows; T12. Mineral Hill district; T13. Blue Wing district; T14. Bavonore district; T15. East Fork district; T16. Summit Creek district; T17. Wildhorse district; T18. Mackay district; T19. Atlanta district; T20. Boulder Creek; T21. Muldoon Area; T22. Camas district; T23. Mineral Hill district; T24. Corral Creek; T25. Lava Creek district.

WGM Inc.		Mining and Geological Consultants Anchorage, Alaska	
BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS		Donkey Hills GRA, Idaho	
Regional Mineralization		FIGURE 13	
SCALE:	DATE 3/1983	APPROVED	DATE
DRAWN BY DSI	APPROVED G.F.		

Hills GRA. Green (1972) describes this belt as a prominent trend of lineations, trending N45°W, recognizable on aerial photographs. The belt terminates at its northern end. It is 10 miles wide and extends for at least 130 miles along-strike. More than 100 occurrences of gold, silver, lead, zinc, tungsten, antimony, molybdenum and mercury are aligned along the Florence-Stibnite mineral belt.

The Donkey Hills GRA is included in the NURE compilation (Wodzicki and Krason, 1981) on the Dubois Quadrangle. Results of NURE sampling are summarized in Table IV below.

TABLE IV

SUMMARY OF URANIUM GEOCHEMICAL SAMPLING DONKEY HILLS GRA, IDAHO

(Data from Wodzicki and Krason, 1981)

<u>Sample Type</u>	<u>Number of Samples</u>	<u>Range of Uranium Content</u>	<u>Threshold Value for Uranium</u>
Stream Sediment	27	1-11 ppm ¹	19 ppm
Stream Water	31	less than 1-6 ppm	10 ppb
Waterwell and Spring	10	1-6 ppb	12 ppb
Rock	1	3 ppb	-----

1. Total uranium content.

No areas favorable for uranium deposits were delineated within the Donkey Hills GRA, however, the McGowan Creek Formation was found to be uraniferous during their evaluation of the Beaverhead Range. Since it was late in the field season, this unit was not evaluated for uranium in the Lost River Range. Although Wodzicki and Krason (1981) theorize that the uranium content of the McGowan Formation in the Lost River Range may be lower than

in the Beaverhead Range due to the dilutive effective of a higher sedimentation rate, they recommend that the McGowan be evaluated for uranium in the Lost River Range. Wodzicki and Krason (1981) also found the environments of several of the post-Paleocene basins outside of the Donkey Hills GRA to be favorable environments for uranium deposits. The basins (Thousand Springs, Little Lost River, and the southern part of the Pahsimeroi River basin) within the Donkey Hills GRA could not be evaluated due to poor exposure. However, on the basis of the geochemical data, they rated the near-surface portions of these basins as unfavorable for uranium deposits.

The Donkey Hills GRA is within the Central Idaho Basin and Range geothermal province which occupies the area between the Idaho batholith on the west, the Montana Basin and Range province on the east, and the Snake River Plains on the south. The area is distinguished from the Montana Basin and Range in that the bedrock of the province is predominately Precambrian and Paleozoic sedimentary rocks which have been extensively thrust faulted. The Eocene Challis Volcanics are the youngest volcanic rocks exposed in this province. Normal faulting appears to have been active until very recent times. In addition, a seismic trend extending westward from Yellowstone National Park passes through the center of the province. A zone of seismic activity is present just west of the Central Idaho Basin and Range geothermal province and an east-west trend of seismic activity is also present along the Centennial Mountains on the Montana border just east of the province (Smith, 1978). The hot spring frequency in the Central Idaho Basin and Range geothermal province is somewhat lower than in the Montana and Basin Range province; however, the Central Idaho Basin and Range province is virtually unknown on even a reconnaissance geothermal or geophysical basis. Typical

heat flow values are probably the same as the Montana Basin and Range province, but very little data is available. Due to the abundance of carbonate rocks in the province, the hydrology is probably more complicated than in the Montana Basin and Range province where less permeable granitic and metamorphic rocks predominate. However, it is not possible to predict the influence that bedrock hydrology might have on the location of geothermal systems in the Central Idaho Basin and Range province using existing data.

In the Donkey Hills GRA, the hydrology of the Pahsimeroi River Basin including the Goldberg and Burnt Creek WSAs has been discussed by Young and Harenburg (1973). No warm wells or springs were identified during the course of that study. The heat flow and geothermal gradients in the GRA are almost completely unknown. Barney Warm Spring, in the middle of the Lost River Valley, has a discharge of 643 l/min. at 28°C and a maximum temperature of 59°C (Mitchell et al., 1980). The controls on its location are unknown, but the hot springs in this province are generally near a range-valley contact suggesting control by major range bounding structures. Thus, low temperature systems associated with major fault structures may exist in the Donkey Hills GRA, particularly where these fault structures intersect low elevations. Unpublished gradients from a 1,400 foot deep mineral exploration test in the Lemhi Valley, about 20 miles east of the Donkey Hills GRA in T.13N., R.27E., are 85°C/km (4.7°F/100 ft.) and the bottom hole temperature is 37°C. Heat flow values and gradients in the Lemhi Range (sec. 7, T.14N., R.26E.) are 60 milliwatts per square meter and 25°C/km (1.4°F/100 ft.), slightly below normal for the Central Idaho Basin and Range geothermal province (Brott et al., 1976).

The Donkey Hills GRA is a part of the Cordilleran fold-thrust belt. Major hydrocarbon reserves are present 200 miles southeast of the GRA in western Wyoming where three giant oil fields (Lamb, 1980; McCaslin, 1981) and 12 other fields are currently being developed. Some of the latter may be classed in the giant ranks when fully developed. Production within this area is from several horizons including Ordovician, Devonian, Mississippian, Pennsylvanian, Triassic, and Jurassic units (McCaslin, 1980, 1981). In the Donkey Hills GRA most of these Paleozoic units have equivalents, but Triassic and Jurassic rocks are not present. The nearest test well to the GRA was drilled in sec. 16, T.12N., R.18E., approximately 20 miles east of the Goldburg WSA. No information is available on this test other than it was plugged and abandoned. As shown by Breckenridge (1982) numerous dry holes have been drilled in southeastern Idaho 75 to 190 miles to the southeast of the Donkey Hills GRA. Hydrocarbon shows have been reported in some of these tests. Except for the absence of a relatively thick Mesozoic section the Donkey Hills GRA is similar stratigraphically and structurally to southwestern Montana. General evaluations of the hydrocarbon potential of the southwestern Montana area have been made by Scholten (1967), Perry et al. (1981) and Peterson (1981). Scholten (1967) considered the area to have a low potential whereas both Peterson (1981) and Perry et al. (1981) considered the area to have some potential but concluded that further study was necessary.

Potential hydrocarbon source beds in the Donkey Hills GRA are the dark shales of the McGowan Creek Formation (Milligen Formation of some authors), argillaceous limestones and calcareous shales of the Jefferson Formation, and dark clayey-silty limestones of the South Creek Formation. All of these

units except the South Creek Formation have had hydrocarbon analyses made on them from localities in east-central Idaho or southwestern Montana. A petroleum company had samples of the Milligen Formation (probably McGowan Creek Formation) from the White Knob and Lost River Ranges west and south of the Donkey Hills GRA analyzed. The results of these analyses indicate that the unit has a mature, very poor oil, good to excellent wet-gas condensate source character (Nance Petroleum pers. comm., 1982). The organic carbon content of well-cuttings from the Three Forks Formation in southwestern Montana is 7.5% (Perry et al., 1981). This clearly implies that the Three Forks could be a hydrocarbon source bed where similar lithologies are present in the Donkey Hills GRA.

Thermal maturity of source beds within the Donkey Hills GRA has not been studied. However, the data known from the south and west (Nance Petroleum pers. comm., 1982) and the conodont color alteration indices reported for Mississippian strata in southwestern Montana (Perry et al., 1981) indicate that the thermal maturity has been of sufficient magnitude within the region to generate hydrocarbons.

Potential hydrocarbon reservoir beds in the Donkey Hills GRA include vuggy dolostones of the Laketown Dolomite, sucrosic dolostones in Ordovician, Silurian and Devonian strata, and sandstones and conglomerates within the late Paleozoic strata. Fracture porosity may also occur in these units. The thrust faults and block uplifts of the region should provide structural traps for the reservoir beds.

The Quaternary glacial and alluvial deposits present in the Donkey Hills GRA probably contain abundant sand and gravel resources.

3.5 Mineral and Energy Economics

Although the region encompassing the Donkey Hills GRA is sparsely populated, the existing transportation infrastructure is adequate; thus, given sufficient reserves, grade and reasonable metal and energy prices, development of any metallic mineral or hydrocarbon deposits should not be impeded. In addition, two nearby developments, when completed, should improve the economic feasibility of any cobalt or tungsten/molybdenum deposits which might be discovered in the Donkey Hills GRA. These developments are (Bennett et al., 1982):

1. An announcement by Noranda that it plans to reopen the Blackbird mine at Cobalt, Idaho and build a \$50 million cobalt refinery near Moreland, Idaho.
2. An announcement by Inspiration Development Company that it plans to reopen the Ima mine as a tungsten-molybdenum producer.

These two projects are presently dormant due to low metals prices, but their completion could provide a nearby mill for similar deposits in the region.

The economic feasibility of geothermal resource development is determined by its distance to market and its temperature. Long-distance transportation of lower temperature geothermal energy is not feasible whereas for electrical

grade resources long transportation distances are feasible. Based on present requirements for the use of hot fluids in electrical generating techniques, geothermal systems with temperatures of less than 150°C do not have significant potential for electrical exploitation. However, geothermal resources with temperatures less than 150°C do have significant potential for low and intermediate temperature geothermal utilization for space heating, material processing, etc. if their minimum temperature exceeds 40°C. At the lower end of the spectrum, as the energy content of the resource becomes less, or the drilling depth necessary for exploitation becomes greater, there is a very ill-defined cutoff. For example, shallow ground water temperatures on the order of 10-20°C can be used for heat pump applications, and in some cases these are considered geothermal resources. However, in this evaluation, a lower temperature than approximately 40°C is considered uneconomic as a geothermal resource.

Although sand and gravel resources in the Donkey Hills GRA are probably plentiful, they are too far away from potential markets to be economic except for local use.

4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

4.1 Explanation of Classification Scheme

In the following sections the four WSAs in the Donkey Hills GRA are classified for geology, energy and mineral (GEM) resources potential. The classification scheme used is shown in Table V. Use of this scheme is specified in the contract under which WGM prepared this report.

The evaluation of resource potential and integration into the BLM classification scheme has been conducted using a combination of simple subjective and complex subjective approaches (Singer and Mosier, 1981) to regional resources assessment. The simple subjective approach involves the evaluation of resources based on the experience and knowledge of the individuals conducting the evaluations. The complex subjective method involves use of rules, i.e. geologic inference, based on expert opinion concerning the nature and importance geologic relationships associated with mineral and energy deposits (Singer and Mosier, 1981).

The GEM evaluation is the culmination of a series of tasks. The nature and order of the tasks was specified by the BLM, however they constitute the general approach by which most resource evaluations of this type are conducted. The sequence of work was: (1) data collection, (2) compilation, (3) evaluation, and (4) report preparation. One day of field work was done in the Donkey Hills GRA.

TABLE V
BUREAU OF LAND MANAGEMENT GEM RESOURCES LAND CLASSIFICATION SYSTEM

CLASSIFICATION SCHEME	LEVELS OF CONFIDENCE
1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.	A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.
2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.	B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.	C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.	D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Each WSA is classified for locatable, leasable, and saleable resource potential.

Locatable minerals are those which are locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, non-metallic minerals such as asbestos, barite, zeolites, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumicite, clay magnesite, silica sand, etc. (Maley, 1983).

Leasable resources include those which may be acquired under the Mineral Leasing Act of 1920 as amended by the Acts of 1927, 1953, 1970, and 1976. Materials covered under this Act include: asphalt, bitumen, borates of sodium and potassium, carbonates of sodium and potassium, coal, natural gas, nitrates of sodium and potassium, oil, oil shale, phosphate, silicates of sodium and potassium, sulfates of sodium and potassium, geothermal resources, etc. (Maley, 1983).

Saleable resources include those which may be acquired under the Materials Act of 1947 as amended by the Acts of 1955 and 1962. Included under this Act are common varieties of sand, gravel, stone, cinders, pumice, pumicite, clay, limestone, dolomite, peat and petrified wood (Maley, 1983).

4.2 Classification of the Hawley Mountain WSA (32-3)

4.2.1 Locatable Minerals

4.2.1a Metallic Minerals. The Hawley Mountain (32-3) WSA (1a and 2a, Fig. 14) is classified as having low favorability for the occurrence of metallic minerals based on limited direct evidence (2C). The WSA has been mapped at a scale of 1:62,500 (Mapel and Shropshire, 1973) and no metallic mineral occurrences are reported.

4.2.1b Uranium and Thorium. The southeastern portion of the Hawley Mountain (32-3) WSA (2b, Fig. 14) is classified as moderately favorable for the accumulation of uranium based on indirect evidence (3B). The McGowan Creek Formation which is uraniferous in the Beaverhead Mountains is present in the subsurface of area 2b. The remainder of the WSA (1b, Fig. 14) is classified as unfavorable for the occurrence of uranium based on limited direct evidence (1C). No uranium occurrences are known and the environment is generally unfavorable.

4.2.1c Non-Metallic Minerals. All of the Hawley Mountain (32-3) WSA (1a and 2a, Fig. 14) is classified as having low favorability for non-metallic minerals based on limited direct evidence (2C). No occurrences of non-metallic minerals are reported.

Legend For Figure 14

CLASSIFICATION SCHEME

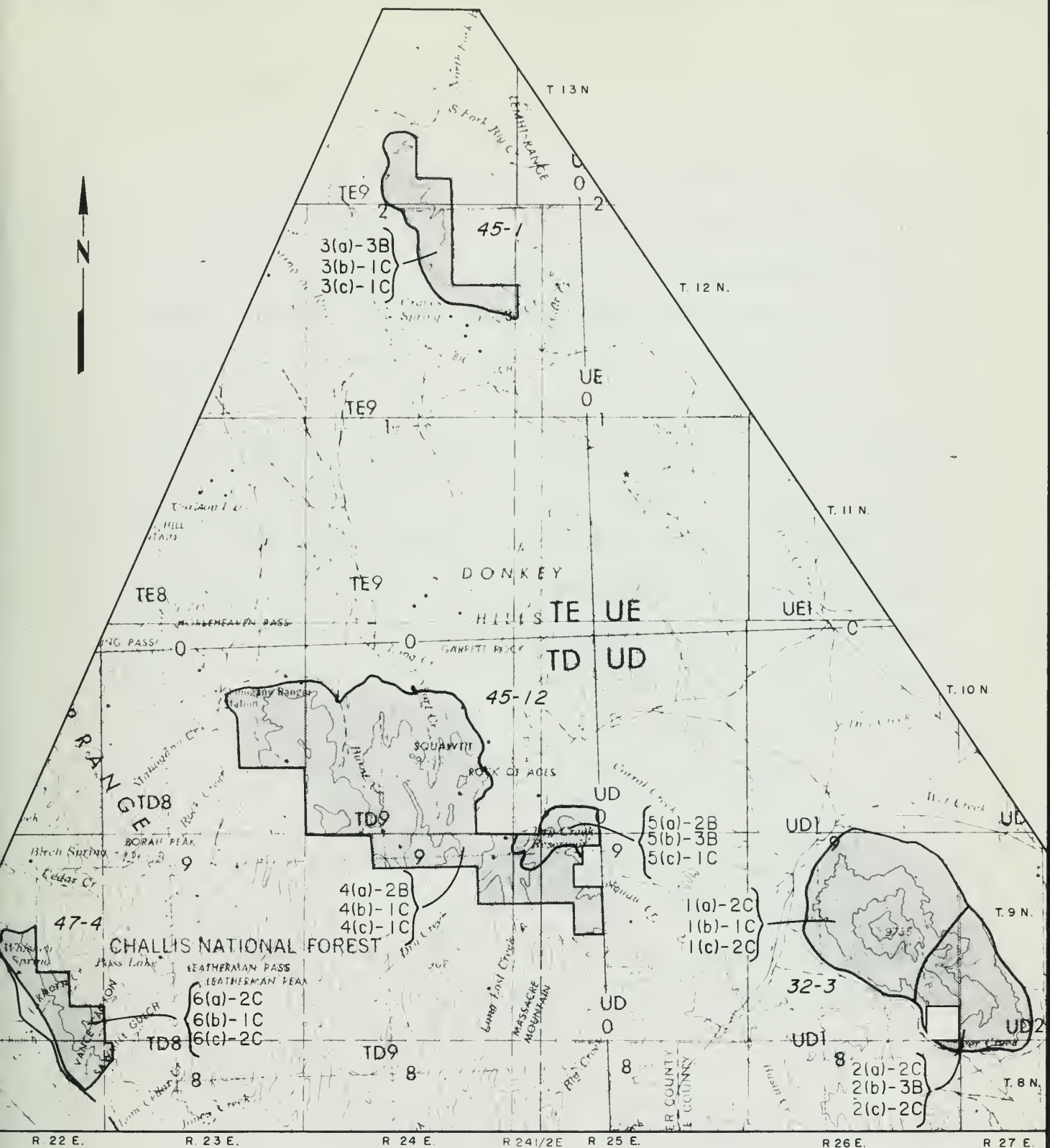
1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

- A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.
- B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.
- C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.
- D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

Area I.D. Number
1(a) - 4D
Commodity Classification
Level of Confidence

- a) Metallic Minerals
- b) Uranium and Thorium
- c) Non-Metallic Minerals



Approximate Boundary of Wilderness Study Area.

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho
Wilderness Study Area
Land Classification
Locatable Resources

SCALE 1" = 4 MILES	FIGURE
DATA BY WGM	DATE 12/1982
DRWN BY DSI	APRVD G F
	REVISED
	14

4.2.2 Leasable Resources

4.2.2a Oil and Gas. The Hawley Mountain (32-3) WSA (1a and 2a, Fig. 15) is classified as having moderate favorability for the accumulation of oil and gas based on limited direct evidence (3C). The regional geological setting is favorable and both potential source and reservoir rocks occur in the subsurface of the WSA.

4.2.2b Geothermal. The northwestern and northeastern edges of the Hawley Mountain (32-3) WSA (1b, Fig. 15) are classified as having low favorability for low to high temperature (40° to over 150°C) geothermal resources based on indirect evidence (2B). This area encompasses the lower elevations in the WSA which might lie along major lineaments or possible range-bounding faults. The remainder of the WSA (2b, Fig. 15) is classified as unfavorable for low to high temperature (40 to over 150°C) geothermal resources based on indirect evidence (1B). This area is topographically high.

4.2.2c Sodium and Potassium. The Hawley Mountain (32-3) WSA (1c and 2c, Fig. 15) is classified as unfavorable for the accumulation of sodium and potassium based on limited direct evidence (1C). The geologic depositional environment of the rocks was unfavorable for deposition of sodium and potassium.

4.2.2d Others. The Hawley Mountain (32-3) WSA (1d and 2d, Fig. 15) is classified as unfavorable for the accumulation of other leasable commodities based on limited direct evidence (1C). No rocks known to contain these commodities underlie the WSA.

Donkey Hills GRA, Idaho
Legend For Figure 15

*BLM LAND CLASSIFICATION SYSEM
 FOR GEM RESOURCES*

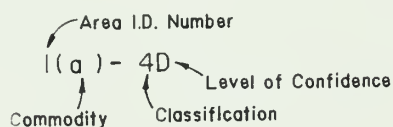
CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

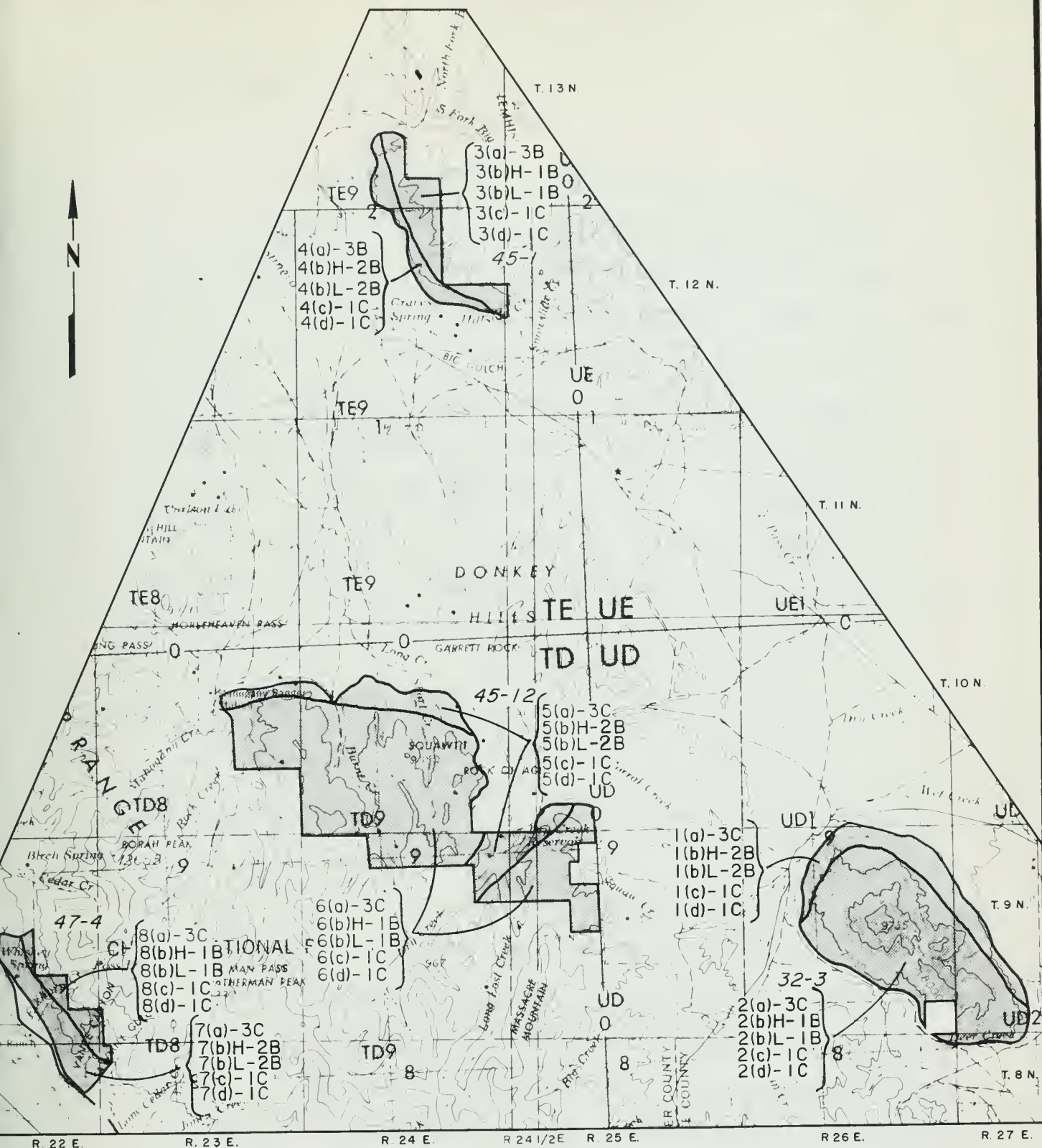
LEVELS OF CONFIDENCE

- A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.
- B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.
- C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.
- D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

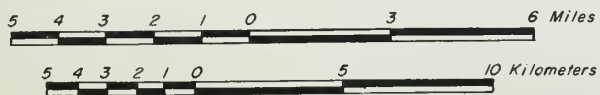
EXPLANATION



- a) oil and gas
- b) Geothermal: high temperature (H), Low temperature (L)
- c) Sodium and Potassium
- d) others: Asphalt (As), bitumen (bt), phosphate (ph), No specific commodity designation indicates that the rating applies to all of the above.



Approximate Boundary of Wilderness Study Area.



WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho
Wilderness Study Area
Land Classification
Leasable Resources

SCALE: 1" = 4 MILES	FIGURE
DATA BY: WGM	DATE 12/1982
DRWN BY: DSI	APRVD: G.F.
	15

4.2.3 Saleable Resources

The northwestern portion of the Hawley Mountain (32-3) WSA (1, Fig. 16) is classified as highly favorable for sand and gravel based on abundant evidence (4D). Geologic mapping by Mapel and Shorsphire (1973) show that gravels underlie the area. However, the area is too far from major markets for the gravel to be economic. The remainder of the WSA (2, Fig. 16) is classified as moderately favorable for common varieties of limestone and dolomite based on abundant evidence (3D). Geologic mapping shows that much of this area is underlain by carbonate rocks (Mapel and Shrosphire, 1973). As with gravel, the location of the area with respect to major markets probably precludes economic development of common varieties of limestone and dolomite.

4.3 Classification of the Goldburg WSA (45-1)

4.3.1 Locatable Minerals

4.3.1a Metallic Minerals. The Goldburg (45-1) WSA (3a, Fig. 14) is classified as moderately favorable for the accumulation of metallic mineral deposits based on indirect evidence (3B). Tungsten-copper-molybdenum-silver mineralization related to small intrusive bodies occurs at the Ima mine, about eight miles northwest of the WSA, and at Big Creek, just north of the WSA. Both of these occurrences are along-strike and in the same rocks which underlie the WSA. In addition, a cobalt occurrence is present in the same strike belt, about two miles north of the WSA. Although the silt sampling results from streams draining the Goldburg WSA were negative, geochemical

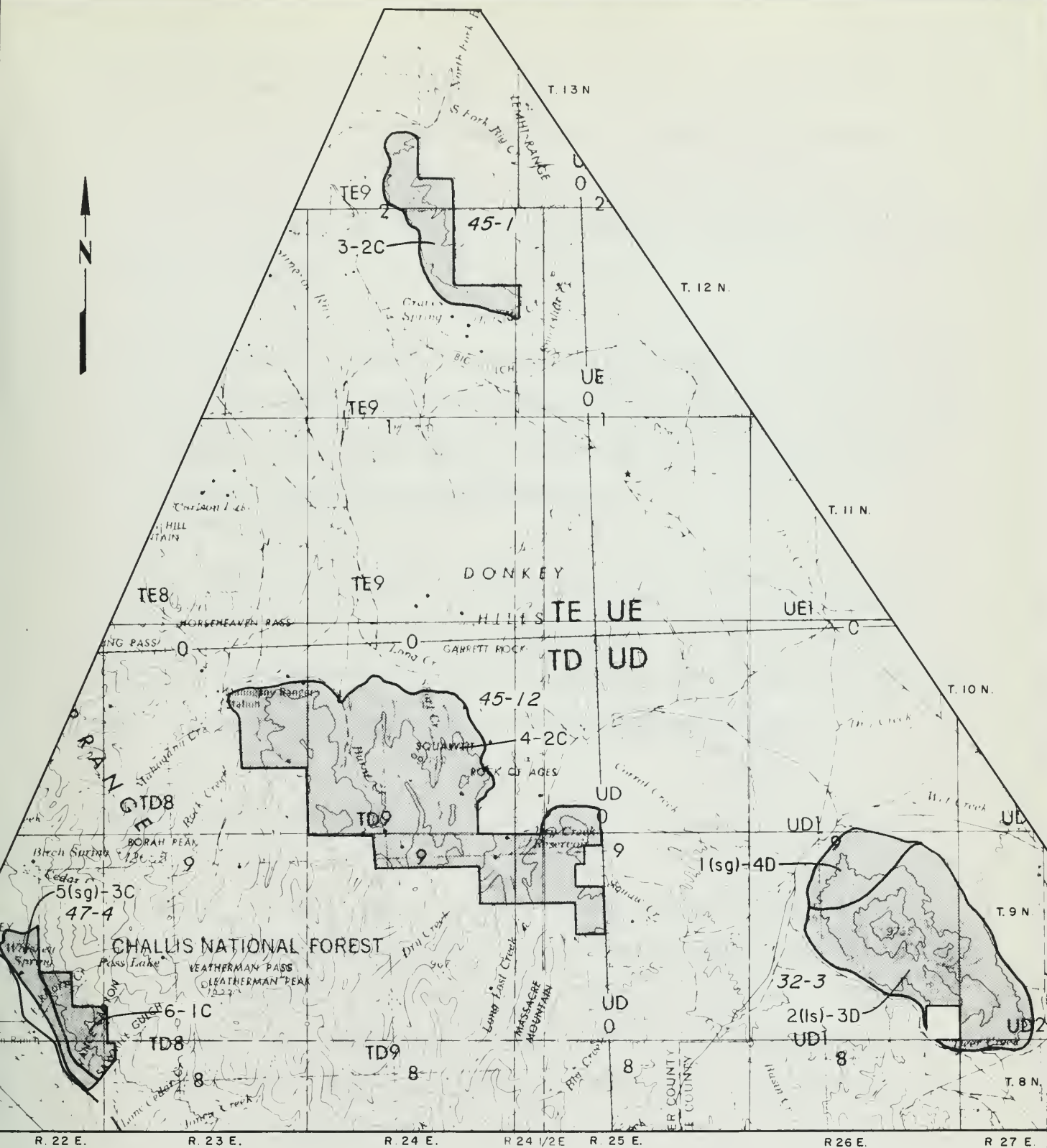
BLM LAND CLASSIFICATION SYSEM
FOR GEM RESOURCES

LEVELS OF CONFIDENCE

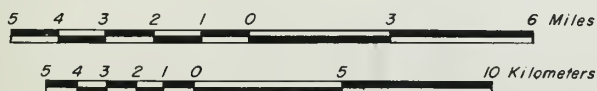
- | | | | |
|----|--|----|--|
| 1. | THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES. | A. | THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA. |
| 2. | THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES. | B. | THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES. |
| 3. | THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES. | C. | THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES. |
| 4. | THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES. | D. | THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES. |

Area I.D. Number
1(1s)-4D
Commodity Classification Level of Confidence

s	Sand
g	Gravel
st	Stone
c	Cinders
p	Pumice
pt	Pumicite
cl	Clay
Ls	Limestone
dl	Dolomite
P	Peat
pw	Petrified wood



Approximate Boundary of Wilderness Study Area.



WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Donkey Hills GRA, Idaho
Wilderness Study Area
Land Classification
Saleable Resources

SCALE: 1" = 4 MILES	FIGURE
DATA BY: WGM	DATE: 12/1982
DRWN BY: DSI	APRVD: G.F.
	REVISED
	16

results are not conclusive without supporting data. Also, any buried mineralization which has not been exposed to weathering would not be detected by stream silt sampling. Thus greater weight was given to the presence of nearby known mineralization in the same strike belt than to the stream silt results.

4.3.2b Uranium and Thorium. All of the Goldburg (45-1) WSA (3b, Fig. 14) is classified as unfavorable for uranium and thorium based on limited direct evidence (1C). The classification is based on the discouraging results obtained from the WSA during the NURE program.

4.3.2c Non-Metallic Minerals. The Goldburg (45-1) WSA (3c, Fig. 14) is classified as unfavorable for the occurrence of locatable non-metallic minerals based on limited direct evidence (1C). The geologic setting of the WSA is generally unfavorable and no occurrences are reported.

4.3.2 Leasable Resources

4.3.2a Oil and Gas. The Goldburg (45-1) WSA (3a and 4a, Fig. 15) is classified as moderately favorable for the accumulation of oil and gas based on indirect evidence (3B). The regional geological setting is favorable and, although the Goldburg WSA is almost entirely underlain by unfavorable Precambrian rocks, both potential source and reservoir rocks probably occur in underlying thrust blocks.

4.3.2b Geothermal. The southwestern edge of the Goldburg (45-1) WSA (4a, Fig. 15) is classified as having low favorability for low to high (40° to

over 150°C) geothermal resources based on indirect evidence (2B). This area comprises the lower elevations in the WSA which might lie along major lineaments or possible range-bounding faults. The remainder of the WSA (3b, Fig. 15) is classified as unfavorable for low to high (40° to over 150°C) geothermal resources based on indirect evidence (1B). This area is topographically high.

4.3.2c Sodium and Potassium. The Goldberg (45-1) WSA (3c and 4c, Fig. 15) is classified as unfavorable for sodium and potassium based on limited direct evidence (1C). The Precambrian quartzites underlying the WSA are not favorable host rocks.

4.3.2d Others. The Goldberg (45-1) WSA (3d and 4d, Fig. 15) is classified as unfavorable for leasable commodities based on limited direct evidence (1C). No rocks known to contain these commodities underlie the WSA.

4.3.3 Saleable Resources

The Goldberg (45-1) WSA (3, Fig. 16) is classified as having low favorability for saleable resources based on limited direct evidence (2C). The WSA is almost entirely underlain by Precambrian quartzites and no large alluvial deposits are mapped in the WSA.

4.4 Classification of the Burnt Creek WSA (45-12)

4.4.1 Locatable Minerals

4.4.1a Metallic Minerals. All of the Burnt Creek (45-12) WSA (4a and 5a, Fig. 14) is classified as having low favorability for metallic mineral deposits based on indirect evidence (2B). The WSA is almost entirely underlain by basaltic and andesitic Challis Volcanics. No prospects or occurrences are reported in these rocks in the region encompassing the Donkey Hills GRA.

4.4.1b Uranium and Thorium. Most of the Burnt Creek (45-12) WSA (4b, Fig. 14) is classified as unfavorable for the accumulation of uranium and thorium based on limited direct evidence (1C). Volcanogenic uranium deposits are usually associated with felsic (rhyolitic) volcanics and this area is underlain by basic volcanics. In addition, sampling results obtained during the NURE program were discouraging. That part of the Burnt Creek (45-12) WSA (5b, Fig. 14) where the McGowan Creek Formation is probably present in the subsurface is classified as moderately favorable for uranium and thorium based on indirect evidence (3B). The McGowan Formation is uraniferous in the Beaverhead Mountains.

4.4.1c Non-Metallic Minerals. All of the Burnt Creek (45-12) WSA (4c and 5c, Fig. 14) is rated as unfavorable for non-metallic minerals based on limited direct evidence (1C). The geological setting is unfavorable and no occurrences are known.

4.4.2 Leasable Resources

4.4.2a Oil and Gas. All of the Burnt Creek (45-12) WSA (5a and 6a, Fig. 15) is classified as moderately favorable for the accumulation of oil and gas based on limited direct evidence (3C). The regional geological environment is favorable and both potential source and reservoir rocks occur in the subsurface of the WSA.

4.4.2b Geothermal. Dry Creek Valley and the northern edge of the Burnt Creek (45-12) WSA (5b, Fig. 15) are classified as having low favorability for both high and low temperature geothermal resources (40° to over 150°C) based on indirect evidence (2B). These areas comprise the lower elevations in the WSA which might lie along major lineaments or range-bounding faults. The remainder of the WSA (6b, Fig. 15) is classified as unfavorable for low to high temperature (40° to over 150°) geothermal resources based on indirect evidence. The area is topographically high.

4.4.2c Sodium and Potassium. The Burnt creek (45-12) WSA (5c and 6c, Fig. 15) is classified as unfavorable for the occurrence of sodium and potassium based on limited direct evidence (1C). The geological setting is unfavorable.

4.3.2d Others. All of the Burnt Creek (45-12) WSA (5d and 6d, Fig. 15) is classified as unfavorable for other leasable commodities based on limited direct evidence (1C). No rocks known to contain other leasable commodities underlie the WSA.

4.4.3 Saleable Resources

The Burnt Creek (45-12) WSA (4, Fig. 16) is classified as having low favorability of the accumulation based on limited direct evidence (2C). A few small areas of glacial and alluvial material are mapped but similar deposits are much more extensive and more accessible elsewhere in the Donkey Hills GRA.

4.5 Classification of the Borah Peak WSA (47-4)

4.5.1 Locatable Minerals

4.5.1a Metallic Minerals. The Borah Peak (47-4) WSA (6a, Fig. 14) is classified as having low favorability for the accumulation of metallic minerals based on limited direct evidence (2C). No metallic occurrences are reported in the units underlying the WSA within the Donkey Hills GRA. Also, rock units hosting the known mineral occurrences within the Donkey Hills GRA are either absent or very deep in the Borah Peak WSA.

4.5.1b Uranium and Thorium. The Borah Peak (47-4) WSA (6b, Fig. 14) is classified as unfavorable for uranium and thorium deposits based on limited direct evidence (1C). No targets of interest were identified during the NURE program and the underlying rocks are unfavorable uranium hosts.

4.5.1c Non-Metallic Minerals. All of the Borah Peak (47-4) WSA (6c, Fig. 14) is classed as having low favorability for non-metallic minerals based on

limited direct evidence (2C). No occurrences are reported in the Donkey Hills GRA region within rocks which underlie the WSA.

4.5.2 Leasable Resources

4.5.2a Oil and Gas. All of the Borah Peak (47-4) WSA (7a and 8a, Fig. 15) is classified as moderately favorable for the accumulation of oil and gas based on limited direct evidence (3C). The regional geological environment is favorable and both potential source and reservoir rocks occur in the subsurface of the WSA.

4.5.2b Geothermal. The southwestern edge of the Borah Peak (47-4) WSA (7b, Fig. 15) is classified as having low favorability for low to high temperature (40° to over 150°C) geothermal resources based on indirect evidence (2B). This area encompasses the lower elevations along major lineaments or along possible range-bounding faults. The remainder of the WSA (8b, Fig. 15) is classified as unfavorable for low to high temperature (40° to over 150°C) geothermal resources based on indirect evidence (1B). This area is topographically high.

4.5.2c Sodium and Potassium. The Borah Peak (47-4) WSA (7c and 8c) is classified as unfavorable for sodium and potassium deposits based on limited direct evidence (1C). No rocks known to contain these commodities underlie the WSA.

4.5.2d Others. The Borah Peak (47-4) WSA (7d and 8d, Fig. 15) is classified as unfavorable for deposits of other leasable commodities based on

limited direct evidence (1C). No rocks known to contain any other leasable commodities underlie the WSA.

4.5.3 Saleable Resources

The southwestern edge of the Borah Peak (47-4) WSA (5, Fig. 16) is classified as moderately favorable for sand and gravel deposits based on limited direct evidence (3C). Geological mapping shows this area to be underlain by alluvial fan deposits. The remainder of the WSA (6, Fig. 16) is classified as unfavorable for saleable resources based on limited direct evidence (1C). Geological mapping indicates the presence of unfavorable host rocks for any saleable commodities.

5.0 RECOMMENDATIONS FOR FURTHER WORK

An aeromagnetic survey of the Donkey Hills GRA would aid in pinpointing buried intrusives thereby improving the mineral assessment of the Goldburg WSA. It would also help in determining if the lead-zinc mineralization present in the southwestern part of the GRA is similar to the mineralization present at Gilmore.

The Wells prospect should be examined thoroughly. The objective of the examination should be to determine whether or not mineralization controls project into the Goldburg WSA.

A geochemical survey of the carbonate terrane in the Donkey Hills GRA might pinpoint additional areas of lead-zinc mineralization. The Hawley Mountain WSA should be included in this survey since the Jefferson Dolomite is present in the WSA.

Accomplishment of the following recommendations would improve the oil and gas assessment within the Donkey Hills GRA:

1. Analyses of potential hydrocarbon source beds such as the McGowan Creek Formation, Jefferson Dolomite, and South Creek Formation, to indicate the types of hydrocarbons expected within the area and also provide a thermal maturity history of the area.
2. Analyses of potential reservoir beds such as the Laketown Dolomite early Paleozoic dolomites, and Carbiniferous sandstones, to aid in the identification of favorable traps.

3. Conodont color alteration index studies of all Paleozoic carbonates in the GRA will provide a thermal maturation history of the Paleozoic stratigraphic section and indicate the types of hydrocarbons generated in the area.
4. Geophysical studies of the region will provide a better structural interpretation and help locate the most favorable traps. Most of the above studies will probably be conducted, if not already completed, by private firms if hydrocarbon exploration is allowed to continue within the area.

The potential of the WSAs for geothermal resources can be adequately assessed by a geologic reconnaissance of the higher ranked areas and a geochemical study of the abundant springs in the Donkey Hills GRA. Evidence of anomalous geochemical temperatures or geologic evidence of geothermal systems should be followed up by geophysical studies.

6.0 REFERENCES AND SELECTED BIBLIOGRAPHY

- Anderson, A.L., 1947, Cobalt mineralization in the Blackbird district, Lemhi County, Idaho: Econ. Geol., Vol. 42, No. 1, pp. 25-46.
- _____, 1948, Tungsten mineralization at the Ima mine, Blue Wing district, Lemhi County, Idaho: Econ. Geol., Vol. 43, No. 3, pp. 181-206.
- _____, 1951, Metellogenic epochs in Idaho: Econ. Geol., Vol. 46, p. 592-607.
- Ball, L., Salisbury, J.W., Kintzinger, D.R., Veneruso, A.F. and Ward, S.H., 1979, The national geothermal exploration technology program: Geophysics, Vol. 44, pp. 1721-1737.
- Bennett, E.H., Miller, M.M., Markland, T.R., Pitman, W.R., Lockard, D.W. and Peterson, J.G., 1982, Developments in Minerals, Mining and Energy in Idaho for 1981: Idaho Bureau of Mines and Geology, Reprint 7, 18 p.
- Beutner, E., 1977, Causes and consequences of curvature in the Sevier orogenic belt: Wyoming Geology Society Guidebook, 29th Annual Field Conf., pp. 353-366.
- Blackstone, D.; 1977, The Overthrust belt salient of the Cordilleran fold belt-western Wyoming, southeastern Idaho, northeastern Utah: Joint Wyoming-Montana-Utah Geol. Assoc. Guidebook, p. 367-384.
- Bradshaw, H.E., 1980, Exploration at the Ima mine: Paper presented to the 86th Northwest Mining Assoc. meeting, Spokane, Washington.
- Breckenridge, R.M., 1982, Oil and gas exploration in Idaho: Idaho Bureau of Mines and Geology, 1 sheet.
- Callahan, W.H., 1967, Some spatial and temporal aspects of the localization of Mississippi Valley-type ore deposits: Econ. Geol. Mon. 3, pp. 14-19.
- Callahan, E. and Lemmon, D.M., 1941, Tungsten resources of the Blue Wing district, Lemhi County, Idaho: U.S. Geol. Survey Bull. 931-A, p. 1-21.
- Christiansen, R.L. and McKee, E.H., 1978, Late Cenozoic volcanic and tectonic evolution of the Great Basin and Columbia Intermontane regions: Geol. Soc. America Memoir 152, p. 283-312.
- Churkin, M., Jr., 1962, Facies across Paleozoic miogeosynclinal margin of central Idaho: American Assoc. Petrol. Geologists Bull., Vol. 46, No. 5, p. 591-596.
- Cole, G.A., Berg, R.B., Cromwell, U.A. and Sonderegger, J.L., 1982, Energy resources of Montana: Mont. Bureau of Mines and Geol. Geologic Map 28, scale 1:500,000.

- Cook, E.F., 1955, Prospecting for uranium, thorium and tungsten in Idaho: Idaho Bureau of Mines and Geology, Pamph. 102, 53 p.
- _____, 1956, Tungsten deposits of south-central Idaho: Idaho Bureau of Mines and Geology, Pamph. 108, 40 p.
- _____, 1957, Radioactive minerals in Idaho: Idaho Bureau of Mines and Geology, Mineral Res. Rpt. 8, 5 p.
- Denison, R.H., 1958, Middle Devonian fishes from the Lemhi Range of Idaho: Fieldiana-Geology, Vol. 16, No. 10, p. 269-288.
- Dover, J.H., 1980, Status of the Antler orogeny in central Idaho - Clarifications and constraints from the Pioneer Mountains, in Fouch, T.D. and Magethan, E.R., eds., Paleozoic paleogeography of the west-central United States: Soc. of Econ. Paleontologists and Mineralogists, Rocky Mountain section, west-central United States paleogeography Symp. 1, p. 371-386.
- Einaudi, M.T., Meinert, L.D. and Newberry, R.J., 1981, Skarn deposits: Econ. Geol. 75th Anniv. Vol., pp. 317-391.
- Ellis, A.J. and Mahon, W.A.J., 1977, Chemistry and geothermal systems: Academic Press, New York, 329 p.
- Garmezy, L. and Scholten, R., 1981, Multiple deformation in a portion of the fold and thrust belt; southern Beaverhead Mountains, east-central Idaho: Geol. Soc. America Abs. with Programs, Vol. 13, No. 4, p. 198.
- Green, W.R., 1972, Delineation of mineral belts in northern and central Idaho: Idaho Bureau of Mines and Geology, Inf. Circ. 22, 8 p.
- Hait, M.H., Jr., 1965, Structure of the Gilmore area, Lemhi Range, Idaho: Pennsylvania State Univ. Ph.D. thesis, Univ. Park, Pennsylvania, 134 p.
- Hait, M.H., Jr. and Scott, W.E., 1978, Holocene faulting, Lost River Range, Idaho (abs.): Geol. Soc. America Abs. with Programs, Vol. 10, No. 5, p. 217.
- Hobbs, S.W., 1964, Tungsten, in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 223-233.
- _____, 1968, Geological setting of metallic ore deposits in the northern Rocky Mountains and adjacent areas, in Ridge, J.D. (ed.), Ore Deposits in the United States 1933-1967: American Institute of Mining Metall. and Petrol. Engs., New York, pp. 1351-1373.
- Huh, O.K., 1967, The Mississippian System across the Wasatch Line east-central Idaho, extreme southwestern Montana: Montana Geol. Society Guidebook 18th Annual Field Conf., p. 31-62.
- Hunt, C.B., 1974, Natural regions of the United States and Canada: W.H. Freeman and Company, p. 409-414.

- Kiilsgaard, T.H., 1964, Silver, lead and zinc, in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 181-194.
- King, P.B., 1969, The tectonics of North America - a discussion to accompany the tectonic map of North America, scale 1:5,000,000: U.S. Geol. Survey Prof. Paper 628, 95 p.
- Kirk, W.S., 1981, Thorium: U.S. Bureau of Mines Minerals Yearbook 1981, Vol. 1, Metals and Minerals, pp. 833-838.
- Kirkham, V.R.D., 1927, A geologic reconnaissance of Clark and Jefferson and parts of Butte, Custer, Fremont, Lemhi, and Madison Counties, Idaho: Idaho Bureau of Mines and Geology Pamph. 19, 47 p.
- Lamb, C.F., 1980, Painter reservoir field -- giant in Wyoming Thrust belt: American Assoc. of Petrol. Geologists Bull., Vol. 64, No. 5, p. 638-644.
- Loucks, G.G., 1977, Geologic history of the Devonian, northern Alberta to southwest Arizona: Wyoming Geol. Assoc. Guidebook, 29th Annual Field Conf., pp. 119-134.
- Mapel, W.J. and Shropshire, K.L., 1973, Preliminary geologic map and sections of the Hawley Mountain Quadrangle, Custer, Butte, and Lemhi Counties, Idaho: U.S. Geological Survey Misc. Field Studies Map MF-546.
- McCaslin, J.C., 1980, Amoco scores deep Nugget hit in Overthrust: Oil and Gas Journal, Vol. 78, No. 33, p. 161.
- _____, 1981, Six new fields make list of United States oil giants: Oil and Gas Journal, Vol. 79, No. 4, p. 153.
- McIntyre, D.H., Hobbs, S.W., Marvin, R.F. and Mehnert, H.H., 1976, Late Cretaceous and Eocene ages for hydrothermal alteration and mineralization, Bayhorse district and vicinity, Custer County, Idaho: Isochron/ west, No. 16, pp. 11-12.
- Meinzer, O.E., 1923, Ground water in Pahsimeroi Valley, Idaho: Idaho Bureau of Mines and Geology Pamph. 9, 35 p.
- Mitchell, A.H.G. and Garson, M.S., 1981, Mineral deposits and global tectonic settings: Academic Press, London, 405 p.
- Mitchell, J.C., Johnson L.L. and Anderson, J.E., 1980, Geothermal investigations in Idaho: Part 9, Potential for direct heat application of geothermal resources: Idaho Dept. of Water Resources, Water Inf. Bull. No. 30, 396 p.
- Mitchell, V.E., Strowd, W.B., Hustedde, G.S. and Benett, E.H., 1981, Mines and prospects of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Mines and Prospects Map Series, 22 p.

- Monley, L.E., 1971, Petroleum potential of Idaho-Wyoming Overthrust belt in Future Petroleum Provinces of the United States -- Their Geology and Potential, I.H. Cram (ed.): American Assoc. of Petrol. Geologists, Mem. 9, Vol. 1, p. 509-529.
- Muffler, L.J.P. (ed.), 1979, Assessment of geothermal resources of the United States, 1978: U.S. Geological Survey Cir. 790, p. 163.
- Noble, J.A., 1970, Metal provinces in the western United States: Geol. Soc. America Bull., Vol. 81, pp. 1607-1624.
- _____, 1974, Metal provinces and metal finding in the western United States: Mineral. Deposit, Vol. 9, p. 1-25.
- Perry, W.J., Ryder, R.T. and Maughan, E.K., 1981, The southern part of the southwest Montana Thrust belt a preliminary re-evaluation of structure, thermal maturation and petroleum potential: Montana Geol. Society 1981 Field Conf. and Symp. Guidebook to southwest Montana, p. 261-273.
- Peterson, J.A., 1981, General stratigraphy and regional paleostructure of the western Montana Thrust belt: Montana Geol. Society Field Conf. and Symp. Guidebook to southwest Montana, p. 5-35.
- Poole, F.G. and Sandberg, C.A., 1977, Mississippian paleogeography and tectonics of the western United States, in Stewart, J.H., Stevens, C.H. and Fritsche, A.E., eds., Paleozoic Paleogeography of the Western United States: Soc. Econ. Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symp. 1, p. 67-85.
- Ramspott, L.D., 1962, Middle Paleozoic faulting along geosynclinal margin north of Snake River Plain: Geol. Soc. American Special Paper 73, p. 221-222.
- Rember, W.C. and Bennett, E.H., 1979, Geologic map of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Geologic Map Series, 1:250,000 scale.
- Rose, P.R., 1976, Mississippian carbonate shelf margins, western United States: U.S. Geological Survey Journal of Research, Vol. 4, No. 4, p. 449-466.
- Ross, C.P., 1931, A classification of lode deposits of south-central Idaho: Econ. Geol., Vol. 26, p. 169-185.
- _____, 1937, Geology and ore deposits of the Bayhorse region, Custer County, Idaho: U.S. Geological Survey Bull. 877, 161 p.
- _____, 1941, The metal and coal mining districts of Idaho, with notes on the non-metallic resources of the State: Idaho Bureau of Mines and Geology Pamp. 57, p. 77.
- _____, 1947, Geology of the Borah Peak Quadrangle, Idaho: Geol. Soc. America Bull., Vol. 58, No. 12, p. 1085-1160.

- Ross, C.P., 1961, Geology of the southern part of the Lemhi Range, Idaho: U.S. Geological Survey Bull., 1081-F, p. 189-260.
- _____, 1962, Paleozoic seas of central Idaho: Geol. Soc. America Bull., Vol. 73, p. 769-794.
- Ross, S.H., 1971, Geothermal potential of Idaho: Idaho Bureau of Mines and Geology, Pamph. 150, 72 p.
- Ruppel, E.T., 1964, Strike-slip faulting and broken basin-ranges in east-central Idaho and adjacent Montana: in Geological Survey Research 1964: U.S. Geological Survey Prof. Paper 501-C, p. C14-C18.
- _____, 1968, Geologic map of the Leadore Quadrangle, Lemhi County, Idaho: U.S. Geological Survey Geol. Quadrangle Map GQ-733.
- _____, 1975, Precambrian Y sedimentary rocks in east-central Idaho in Precambrian and Lower Ordovician Rock in East-central Idaho: U.S. Geological Survey Prof. Paper 889, p. 1-23.
- _____, 1976, Medicine Lodge thrust system, east-central Idaho and southwest Montana: U.S. Geological Survey Open-File Rpt. 76-366, 25 p.
- _____, 1978, Medicine Lodge thrust system, east-central Idaho and southwest Montana: U.S. Geological Survey Prof. Paper 1031, 23 p.
- _____, 1980, Geologic map of the Patterson Quadrangle, Lemhi County, Idaho: U.S. Geological Survey Geol. Quadrangle Map GQ 1529.
- _____, 1982, Cenozoic block uplifts in east-central Idaho and southwest Montana: U.S. Geological Survey Prof. Paper 1224, 24 p.
- Ruppel, E.T. and Lopez, D.A., 1981, Geologic map of the Gilmore Quadrangle, Lemhi County, Idaho: U.S. Geological Survey, Geol. Quadrangle Map GQ 1543.
- Ruppel, E.T., Ruben, J.R., Jr. and Schleicher, D., 1975, Precambrian Z and Lower Ordovician rocks in east-central Idaho in Precambrian and Lower Ordovician rocks in East-central Idaho: U.S. Geological Survey Prof. Paper 889, p. 24-34.
- Ruppel, E.T., Watts, K.C. and Peterson, D.L., 1970, Geologic, geochemical and geophysical investigations in the northern part of the Gilmore mining district, Lemhi County, Idaho: U.S. Geological Survey, Open-File Rpt., 56 p.
- Sandberg, C.A., 1975, McGowan Creek Formation, new name for Lower Mississippian flysch sequence in east-central Idaho: U.S. Geological Survey Bull., 1405-E, 11 p.
- Sangster, D.F., 1976, Carbonate-hosted lead-zinc deposits, in Wolf, K.H. (ed.), Handbook of Stratabound and Stratiform Ore Deposits, Vol. 6, pp. 445-456, Elsevier, Amsterdam.

- Scholten, R., 1957, Paleozoic evolution of the geosynclinal margin north of the Snake River Plain, Idaho-Montana: Geological Society of America Bull., Vol. 68, p. 151-170.
- _____, 1967, Structural framework and oil potential of extreme southwestern Montana: Montana Geol. Society Gudebook 18th Annual Field Conf., p. 7-20.
- _____, 1968, Model for evolution of Rocky Mountains east of Idaho batholith: Tectonophysics, Vol. 16, No. 2 p. 109-126.
- _____, 1973, Gravitational mechanism in the northern Rocky Mountains of the United States, in DeJong, K.A. and Scholten, R., eds., Gravity and Tectonics: New York, John Wiley and Sons, Inc., p. 473-489.
- Scholten, R. and Hait, M.H., Jr., 1962, Devonian System from shelf edge to geosyncline, southwestern Montana-central Idaho, in Three Forks-Belt Mountain Area, and Symp., The Devonian system of Montana and Adjacent Areas, Billings Geological Society, p. 13-22.
- Scholten, R., Keenmon, K.A. and Kupsch, W.O., 1955, Geology of the Lima region, southwestern Montana and adjacent Idaho: Geological Society of America Bull., Vol. 66, p. 345-404.
- Scholten, R. and Ramspott, L.D., 1968, Tectonic mechanisms indicated by structural framework of central Beaverhead Range, Idaho and Montana: Geol. Soc. America Spec. Paper 104, 71 p.
- Singer, D.A. and Mosier, D.L., 1981, A review of regional mineral resource assessment methods: Econ. Geol., Vol. 76, No. 5, p. 1006-1015.
- Skipp, B., 1981, A synopsis of the structure and stratigraphy of south-central Idaho -- contributions by the U.S. Geological Survey since 1975: Montana. Geol. Society Field Conf. Southwest Montana, p. 365-372.
- Skipp, B. and Hait, M.H., Jr., 1977, Allochthons along the northeast margin of the Snake River Plain, Idaho: Wyoming Geol. Assoc. Guidebook 29th Annual Field Conf., p. 499-515.
- Skipp, B. and Hall, W.E., 1980, Upper Paleozoic paleotectonics and paleogeography of Idaho in Fouch, T.D. and Magathan, E.R., eds., Paleozoic Paleogeography of the West-central United States: Soc. of Economic Paleontologists and Mineralogists, Rocky Mountain Section, west-central United States Paleogeography Sump. 1, p. 387-422.
- Skipp, B., Hoggan, R.D., Schleicher, D.L. and Douglass, R.C., 1979, Upper Paleozoic carbonate bank in east-central Idaho - Snaky Canyon, Bluebird Mountain, and Arco Hills Formations and their paleotectonic significance: U.S. Geological Survey Bull. 1486, 78 p.
- Skipp, B., Sando, W.J. and Hall, W.E., 1979, Mississippian and Pennsylvanian (Carboniferous) systems in the United States-Idaho: U.S. Geological Survey Prof. Paper 1110, Ch. AA, p. AA1-AA43.

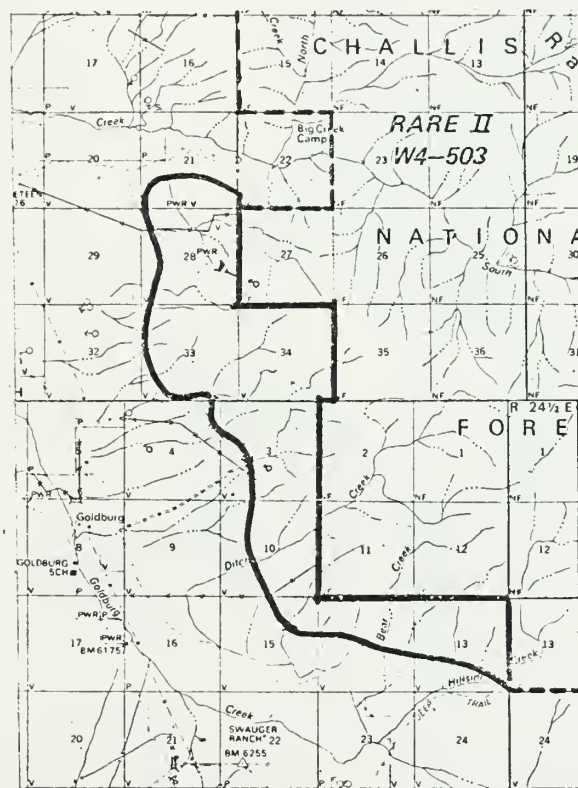
- Sloss, L.L. and Moritz, C.A., 1951, Paleozoic stratigraphy of southwestern Montana: American Assoc. Petrol. Geologists Bull., Vol. 35, No. 10, p. 2135-2169.
- Smith, R.B. and Sbar, M., 1974, Contemporary tectonics and seismicity of the western United States with emphasis on the Intermountain Seismic belt: Geol. Soc. America Bull., Vol. 85, pp. 1205-1218.
- Swanberg, C.A. and Blackwell, D.D., 1973, Areal distribution and geophysical significance of heat generation in the Idaho batholith and adjacent intrusions in eastern Oregon and western Montana: Geol. Soc. America Bull., Vol. 84, p. 1261-1282.
- Trites, A.F., Jr. and Tooker, E.W., 1953, Uranium and thorium deposits in east-central Idaho and southwestern Montana: U.S. Geological Survey Bull. 988-H, p. 157-209.
- Umpleby, J.B., 1913, Geology and ore deposits of Lemhi County, Idaho: U.S. Geological Survey Bull. 528, 182 p.
- Vhay, J.S., 1948, Cobalt-copper of the Blackbird district, Lemhi County, Idaho: U.S. Geological Survey, Strategic Minerals Inv. Prelim. Rpt. 3-219, 26 p.
- Weiss, P.L., Armstrong, F.C. and Rosenblum, S., 1958, Reconnaissance for radioactive minerals in Washington, Idaho and western Montana, 1952-1955: U.S. Geological Survey Bull. 1074-B, p. 7-48.
- Wodzicki, A. and Krason, J., 1981, National uranium resource evaluation, Dubois Quadrangle, Idaho and Montana: U.S. Dept. of Energy, Rpt. GJQ-008(81), 67 p.
- Young, H.W. and Harenburg, W.A., 1973, A reconnaissance of the water resources in the Pahsimeroi River Basin, Idaho: Idaho Dept. of Water Adm. Water Info. Bull. 31, 57 p.

APPENDIX I

WILDERNESS STUDY AREA MAPS

45-1
GOLDBURG

R. 24 E.



T.
13
N.

T.
12
N.

LEGEND

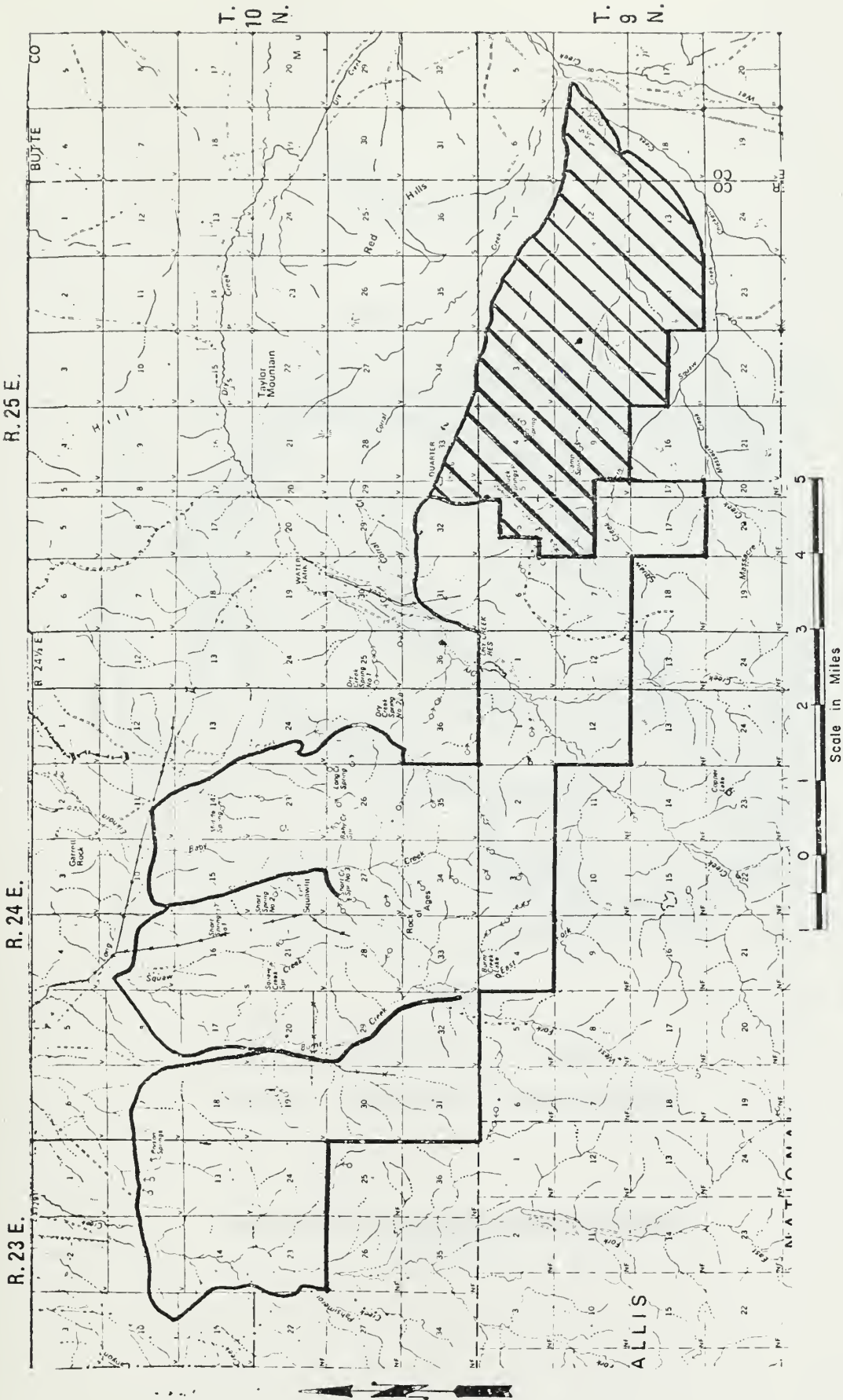


WILDERNESS STUDY AREA

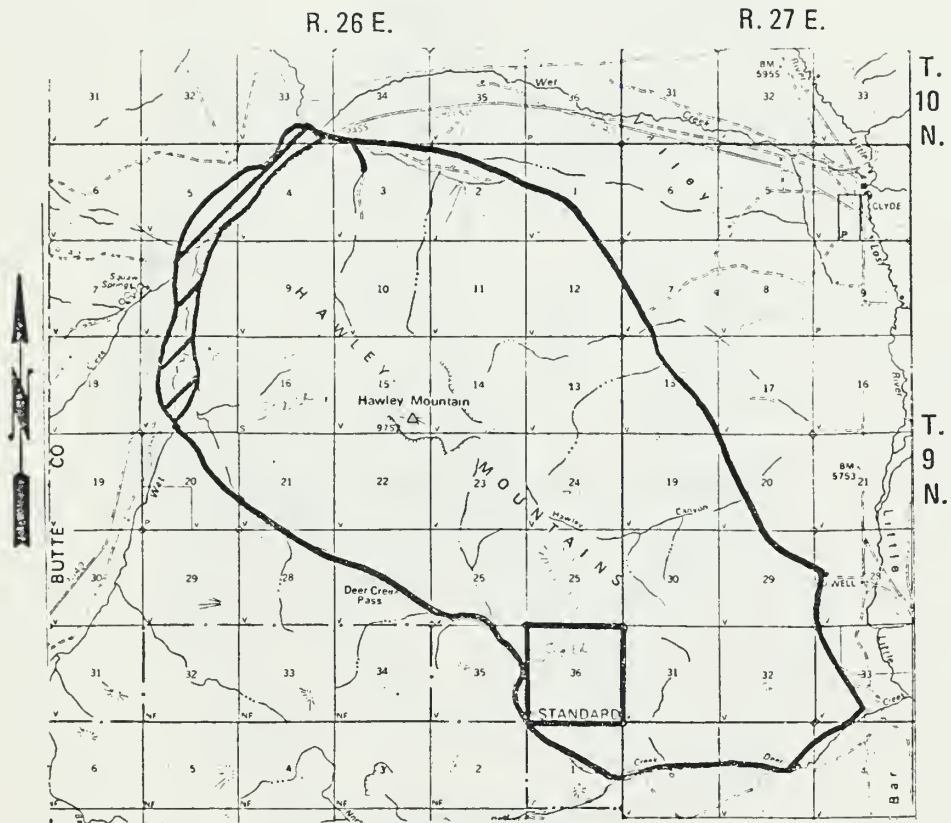


AREA WITHOUT CHARACTERISTICS

45-12
BURNT CREEK

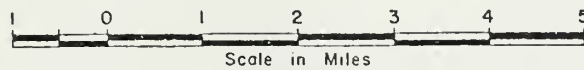


32-3 HAWLEY MOUNTAIN



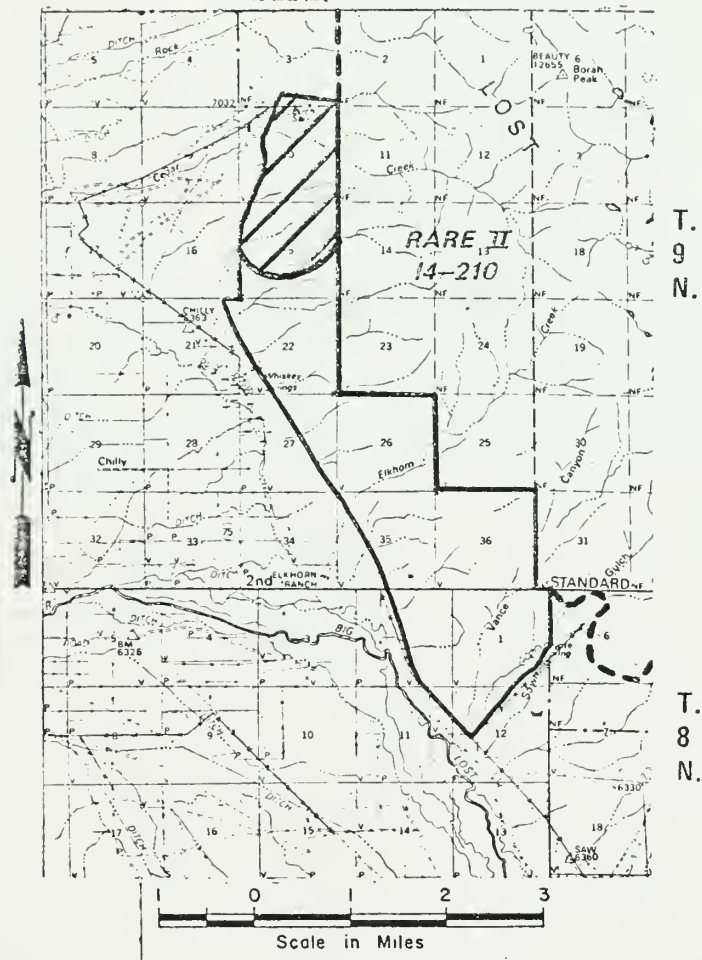
LEGEND

-  WILDERNESS STUDY AREA
-  AREA WITHOUT CHARACTERISTICS



47-4 BORAH PEAK

R. 22 E.



LEGEND

-  WILDERNESS STUDY AREA
-  AREA WITHOUT CHARACTERISTICS

APPENDIX II

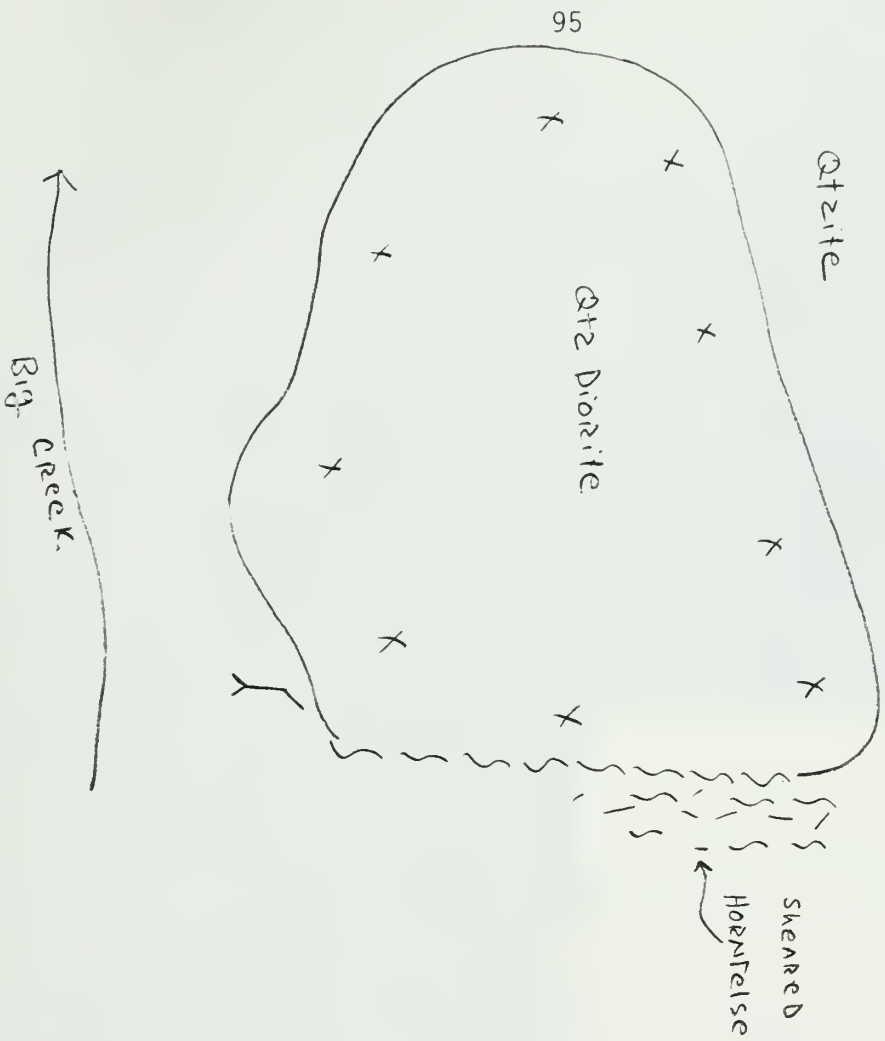
FIELD VISIT REPORT

To: Donkey Hills GRA File
Fm: Greg Fernette, Bill Jones

Re: Field Visit to Goldburg WSA, Big Creek Prospect, and Ima Mine,
October 8, 1982

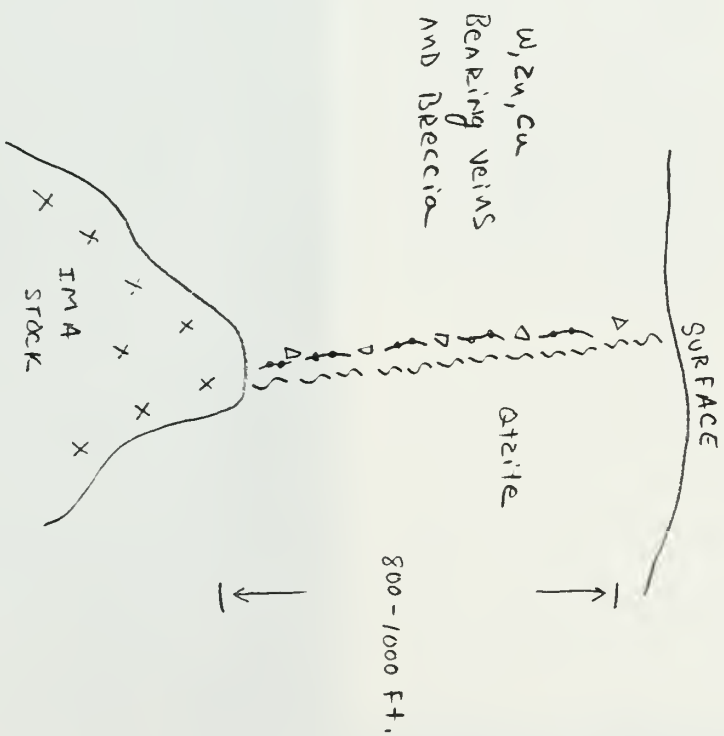
Fourteen stream silt samples (Nos. 28005-28012 and 28024-28029) were collected from streams draining the Goldburg WSA. These samples were sent to Rainbow Resource Labs in Anchorage to be analyzed for copper, zinc, molybdenum, and cobalt. The only rock type noted during collection of the silt samples was tan quartzite.

An examination of the Big Creek prospect and the Ima mine showed that the geological setting of the two occurrences is similar. The Big Creek prospect consists of disseminated pyrite and chalcopyrite in sheared and hornfelsed quartzite along the contacts of a small quartz-diorite stock. Mineralization at the Ima mine consists of scheelite, hubernite, tetrahedrite and lesser sphalerite, galena, pyrite and chalcopyrite in quartz veins. The veins are steeply dipping and occur above a granitic(?) intrusive which does not outcrop. These relationships are illustrated in the attached figure.



Big Cr. Cu-Ag
Prospect

Sketch Map



IMA MINE
Sketch Cross Section

Form 1279-3
(June 1984)

BORROWER'S

DE 104 .D66 F47 1983
Farnette, Greg.
Geology, energy and
(GEM) resource asse

DATE LOANED	BORROWER

USDI - BLM

